Electronics & Technology Today

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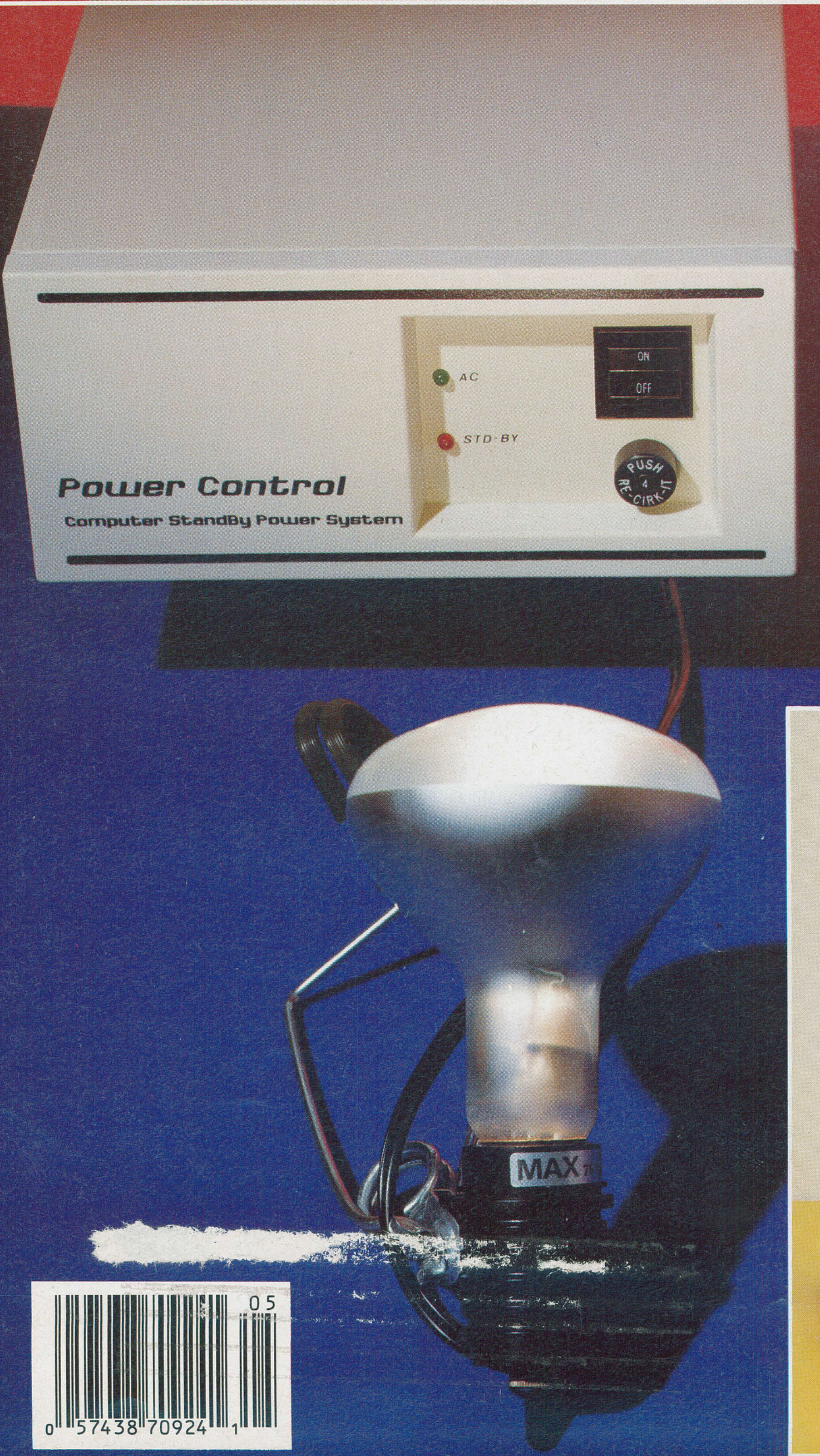
Canada's Magazine for High-Tech Discovery

May 1988



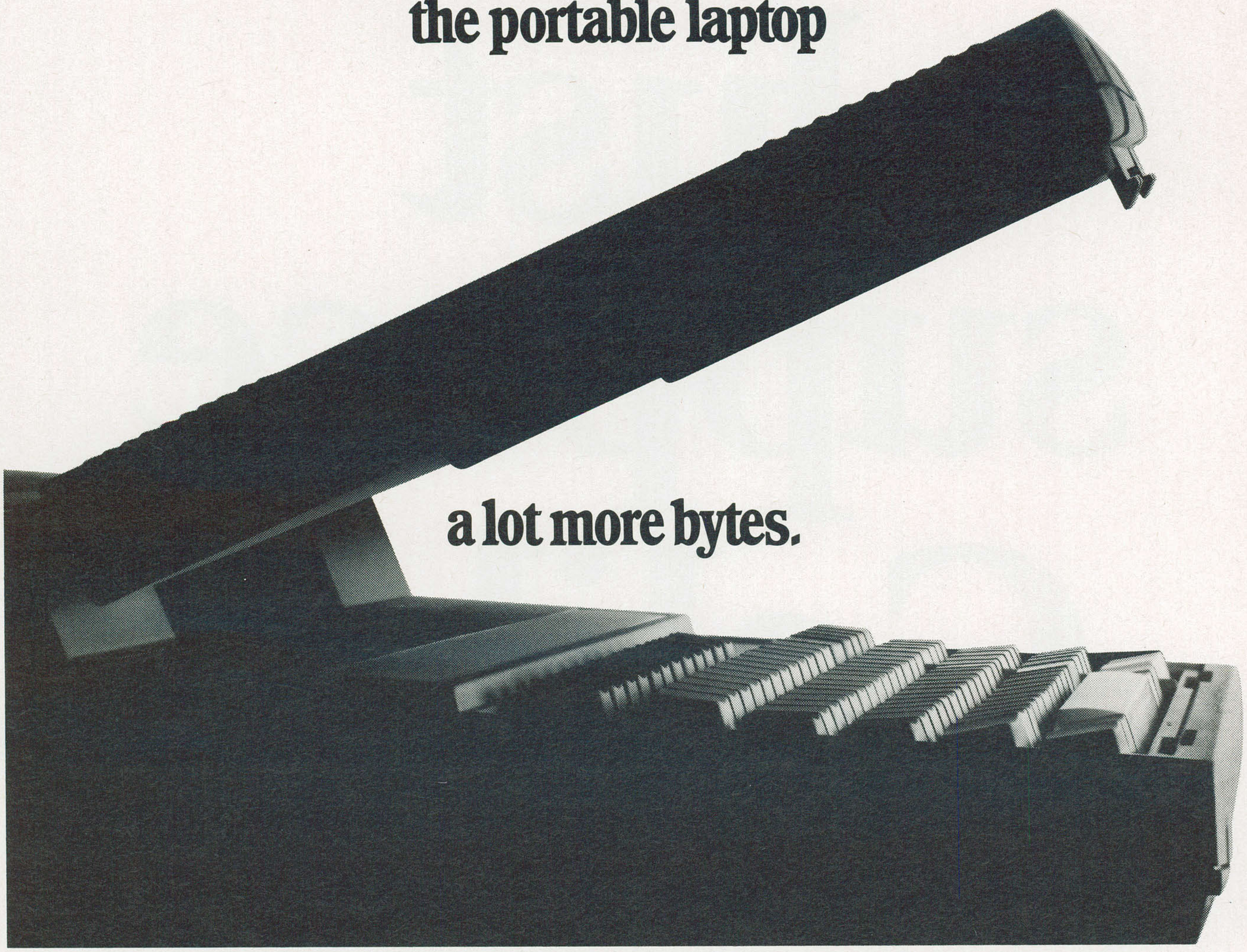
Pseudo Echo Unit

Capacitance Meter

Toshiba T5100 386 Laptop


BEST
BEST

Toshiba has just given the portable laptop



a lot more bytes.

Introducing the exciting new Toshiba T3200. The portable laptop computer designed to take a big bite out of the desktop AT market.

While you're chewing over that data, consider some other major features of the T3200. It's a portable laptop that comes standard with one and one-half internal IBM*-compatible slots for hardware expansion and a fast 40-megabyte internal hard disk drive.

The T3200 moves fast too, with an 80286 microprocessor running at 12MHz. It's also very easy to read, with a superb Gas Plasma screen which is EGA (Enhanced Graphics Adapter) compatible. And it has even more bytes with the standard one megabyte of RAM, upgradable to four megabytes. There's also a separate numeric keypad within the full standard keyboard, for real ease of use. And with all this, there's the added advantage of true portability.

To learn more about the multi-purpose T3200, place a call to your authorized Toshiba re-seller, or call Toshiba direct at 1-800-387-5645. Ask for a demonstration. Once you've had a taste of the new T3200, you'll be spoiled for any other PC, desktop or portable.

The best keep getting better!

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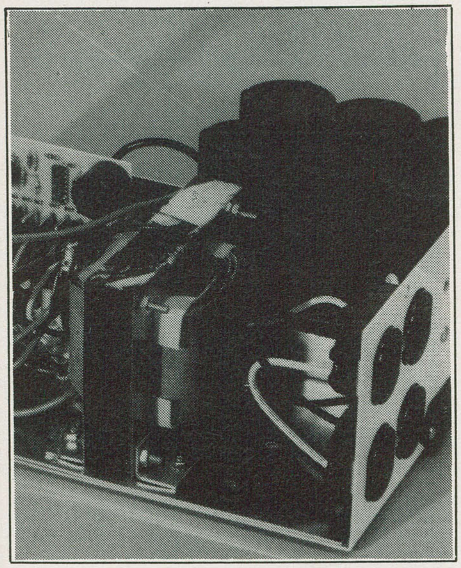

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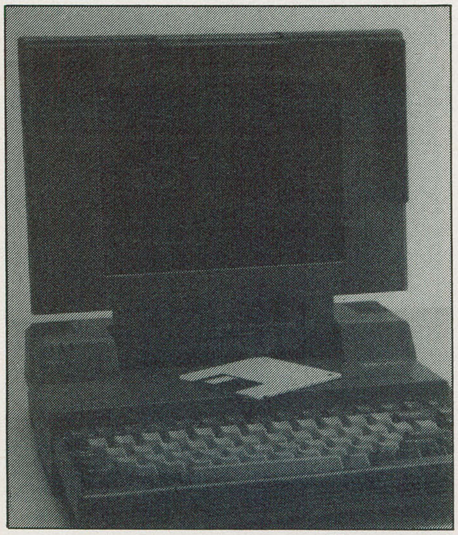

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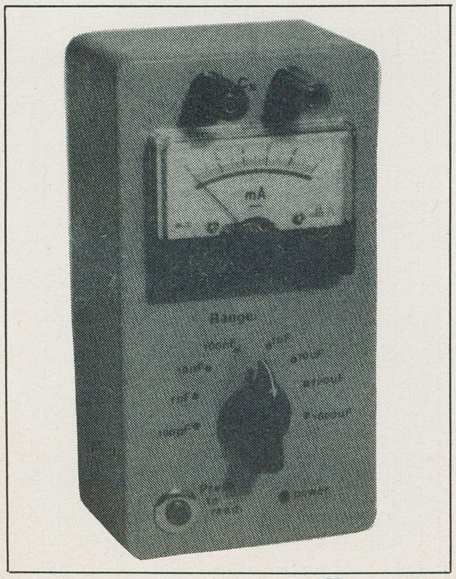

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Electronics & Technology Today

Canada's Magazine for High-Tech Discovery

Volume 12, Number 5 **May 1988**

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TECHNOLOGY

PROJECTS

INFORMATION

Our Cover

The Power Control ME-400 UPS lights itself up with a floodlight; see page 14. The Toshiba T5100 powerhouse laptop is reviewed on page 46. Photos by Bill Markwick

FOR YOUR INFORMATION

Counting Photons

If you need to measure light right down to the last photon, the Infrared Time-Correlated Single-Photon System from Edinburgh Instruments is said to achieve a new level of noise performance. The low-noise photomultiplier system is intended for decay-time measurements up to 950nm, essential in the field of semiconductor research in the technologies of gallium arsenide and silicon. The system gives 400 counts/second noise when cooled to -30 degrees C. For more information, contact Edinburgh Instruments Ltd., 431 Boler Road, Suite 147, London, Ontario N6K 2K8, (519) 471-3612.

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Programmable Resistance Standard

Using a high-resolution A/D converter under microprocessor control, the Valhalla 2724A provides 10 million resistance values from 1000 microohms to 11 gigohms. For ATE engineers requiring an IEEE-488 simulated resistive thermal device, the 2724A can simulate the ohmic value with an accuracy of 7 ppm. Other features include short term stability to 2 ppm, 2/4 terminal operation and IEEE-488 compatibility. Valhalla Scientific is represented in Canada by Duncan Instruments, 121 Milvan Drive, Toronto, Ontario M9L 1Z8, (416) 749-4448.

Circle No. 4 on Reader Service Card

Elementary, My Dear CPU

The Toronto police force has become the first organization outside Britain to sign a contract for HOLMES, a computer system used in the UK for compiling and transmitting information. The Toronto force will have a central computer to link 18 divisions and more than 20 specialized units, including mounted and marine. Police at an unlimited number of terminals will be able to key in information and seek relevant detail from the central computer, consult indexes and record action taken. The system uses UNISYS (Burroughs) B25 computer workstations.

Tandy Acquires Grid

The Tandy Corporation (Radio Shack) and Grid Systems Corporation have signed a definitive agreement for the acquisition of Grid, which will become a wholly-owned subsidiary of Tandy. Grid Systems, manufacturers of battery-operated laptop computers, software and peripherals, is headquartered in California, with sales offices in Canada and Europe. Grid will continue to market under its current name, and will benefit from Tandy's materials sourcing, nationwide service and financial strength.

The Eye's Software

A biomedical engineer at the University of Southern California has developed a theoretical approach to explain how the eye alerts the brain to objects in motion. Vasilis Z. Marmarelis said that we need to develop an understanding of how the eye works as a detector and processor of visual information if we are going to communicate the skill of sight to robots. His theory is that specialized retinal neurons code the information for transmission to the brain. These neurons, called bipolar cells because they both receive and transmit, compose one of the retina's middle layers. They receive electrical signals from the retina's outer layer of photoreceptor and horizontal cells and send them to its innermost layer, composed of amacrine and ganglion cells. The ganglion cells, in turn, transmit the signals through the optic nerve to the brain.

A mathematical model of how the cells transform visual information in space and time is being developed. The next step would be a computer simulation of that process. The ultimate step would be to design an electronic device that would give robots motion-perception skills.

Color Videophone

The Ricoh Company of Tokyo is experimenting with a prototype device that can send and receive color images as well as voice over conventional phone lines. It permits transmission and reception of charts, drawings, photos and other graphic aids. The price and availability have not been determined. The device transmits color images in one to four seconds, as fast or faster than comparable black and white machines currently available. The technology is made possible by advanced data compression techniques.

Other companies have also developed black and white still- picture phones. These have been available in Japan since 1986, and sales are expected to increase with the adoption of compatibility standards. Ricoh hopes that color standards will be in place before they market the new color picture phone.

Continued on page 12

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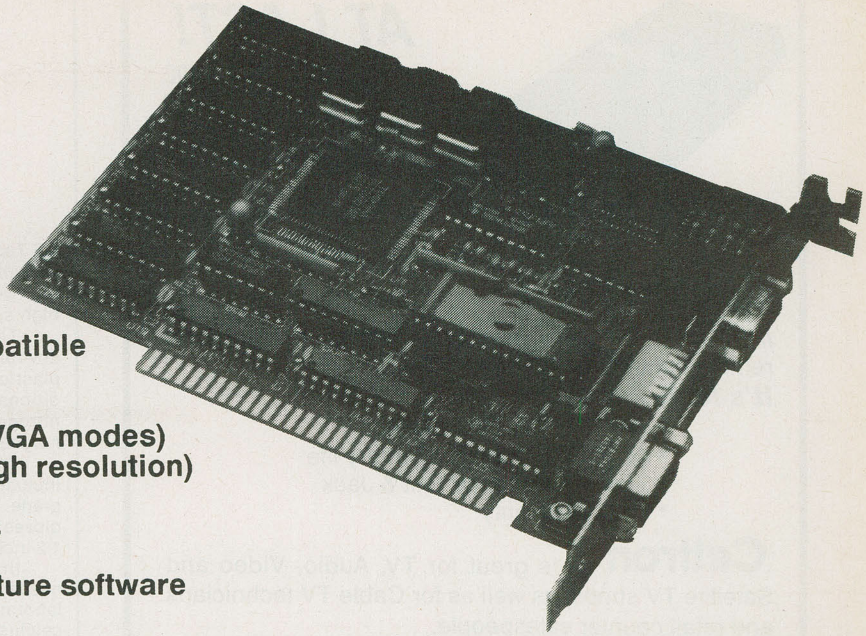

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		LIST
1TECVOM	Tecmar VGA with Tatung Omniscan	1795

This Combo allows the use of all the features of the Tecmar VGA card including VGA, EGA, and high resolution 800x600 with many software packages.

1TECV93	Tecmar VGA with Tatung CM1293 VGA Monitor	1295

This combo is for the budget minded user who wants to have his cake and eat it too. The CM1293 Visual Pro monitor is an analog 12" monitor for VGA. It will support all VGA modes of the Tecmar card and all lower resolution analog modes supported by Tecmar software. This includes ACAD at 640x480, 640x350. Imagine all this for a dealer cost about the same as an EGA board and monitor.

1TECV02	Tecmar VGA with Sony CPD1302	1995

This combo uses the famous CPD1302 with the best VGA card in the industry. The CPD1302 will support all features offered by the Tecmar card. This combo is not for everyone, only for those who want the best.

1TECV03	Tecmar VGA with Sony CPD1303	1895

The newly introduced CPD1303 also supports all features offered by the Tecmar VGA card, but at a lower price than the 1302.

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THE SCIENTISTS TELL ME

By David P. Dempster

Scientists Learn How Complex Materials "Relax"

There's a group of scientists doing research at the University of California, Santa Barbara, who get excited about relaxation, but they don't mean "taking it easy." Rather, Richard Palmer, Daniel Stein and Peter Wolynes are referring to a mysterious property that glass, molasses, a number of vital biological reactions, polymers, and even certain types of computational problems share. The property that is shared is known as slow or extended relaxation. It describes the unusually sluggish way in which such systems respond to external changes, or perturbations.

Palmer is a physicist from Duke University, Stein teaches theoretical physics and does research at the University of Arizona. Wolynes is a chemist at the University of Illinois, Urbana-Champaign. For more than 6 months they have coordinated a program in "Relaxation and Reaction Kinetics" at the university's Institute for Theoretical Physics which has brought together top scientists from around the world to exchange information and views, argue about and analyze this phenomenon.

The discovery of slow relaxation dates back to the 1800s, when the famous mathematician Karl Gauss measured the way in which a silk thread stretches when placed under constant tension.

The current surge of interest has come from a growing conviction that such behavior is a manifestation of a fundamental characteristic of complex materials that scientists do not yet fully understand, the coordinators explain. Generally, systems that exhibit slow relaxation are characterized by an uneasy mixture of order and disorder. That makes them much more challenging than the simpler systems that theoretical scientists have dealt with until recently.

Glasses are a prime example. In materials like crystals and metals, the location of atoms is highly ordered. In glasses, however, the atoms are scattered about randomly. In a very real sense, glass is a liquid frozen in time. Glass flows but with extreme slowness, and the rate at which it flows is characteristic of extended relaxation.

"People have begun to realize that systems of this sort represent a fundamentally new kind of thermodynamical system: a system with many degrees of freedom and with disorder built in. You can't use the old techniques that worked so well for crystals, ferromagnets, superconductors and similar, generally ordered systems. As a result, they require a new type of statistical mechanics to describe adequately," Stein explains.

Boiling water is a typical "phase change." Scientists have used phase changes of this sort to explain everything from the origin of life to the evolution of the universe. But glasses, and other systems that exhibit slow relaxation, appear to embody a qualitatively different type of phase change, one in which the change occurs gradually and partially rather than abruptly and completely.

The scientists think they have a general idea of what is going on. It is analogous to a crowd leaving a theatre after the movie is over. The people filing down the aisles act as barriers to other people trying to get out. Similarly, as the atoms in glass or molasses try to flow in response to gravity, they keep getting in each other's way.

Prior to the program, a large number of apparently conflicting models had been proposed to explain this behaviour. The participants now realize that there is considerably more commonality between the various approaches than people had realized, the organizers report. In fact, a new model that incorporates elements of three early theories has been constructed.

Where do we go with all this knowledge? The researchers say that as such concepts are increasingly refined, they are being applied to such diverse areas as superconductivity, neural networks, combinatorial optimization problems (like airline scheduling), pattern recognition, and the origin of the genetic code.

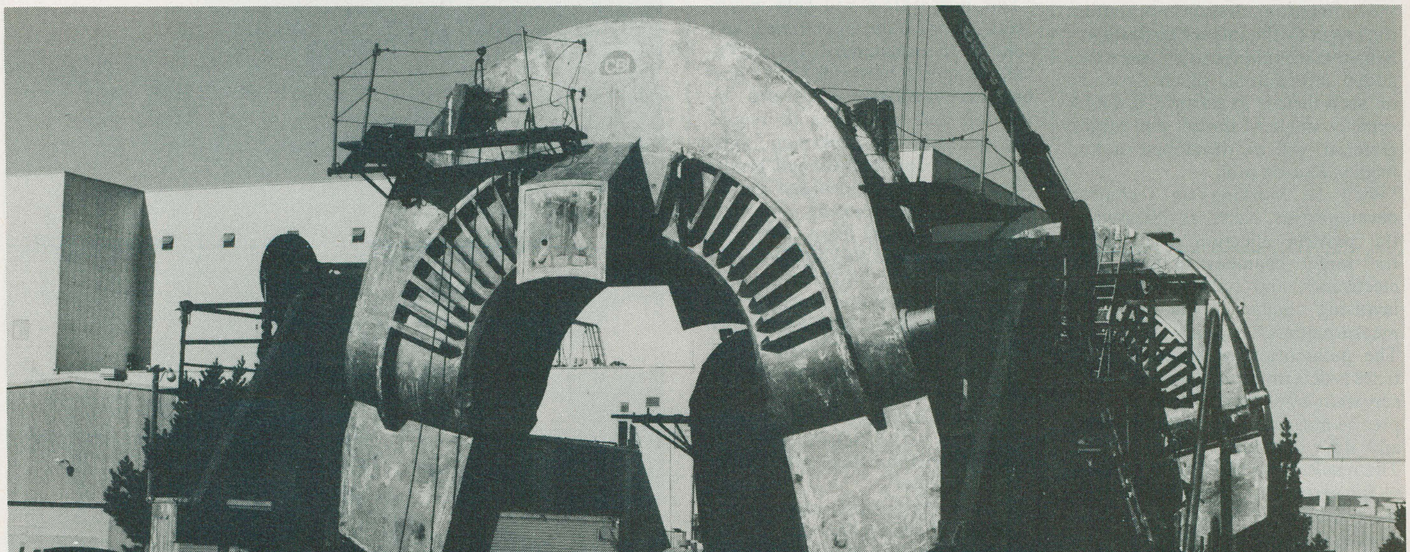
So You Want Fast – Here's Fast

Researchers at Los Alamos National Laboratory, Los Alamos, New Mexico, are really speeding things up. Using a specially modified accelerator, they have pushed tiny particles to speeds of 50 kilometers per second.

The extreme velocity, nearly 112,000 miles per hour, is 50 times faster than a bullet fired from a high-powered rifle, and researchers say the limit has not been reached.

"I'm confident that we'll see 100 kilometers a second because we're still improving the equipment," said Paul Keaton, leader of the project team of scientists and technicians from Los Alamos and Science Applications International Corp.

The 50-km-a-second speed was



recently reached at the Lab's Ion Beam Facility on a Van de Graaff accelerator that was modified for the hypervelocity impact research project.

The milestone was achieved with iron particles the size of individual particles in a cloud of cigarette smoke, each weighing less than two trillionth of a gram.

The research which has applications in space science and defence, is designed to validate existing computer codes developed to describe what happens when particles travelling at high speeds hit something. Experimental verification of the codes for particles of this mass and velocity was previously impossible.

The particles are charged and accelerated to speeds up to one- half kilometer per second, about as fast as a 22-calibre rifle bullet, by a particle source injector that was built by the research team. They are then injected into the Van de Graaff for the final acceleration.

The two-story Van de Graaff is an electrostatic accelerator that uses high voltage and a long vacuum tube to accelerate charged particles. In the recent tests, the potential voltage was set at 5 million volts. It will be set higher when the equipment is refined, allowing the particles to be accelerated to higher speeds.

The research project will focus on a physical phenomenon called momentum enhancement, which occurs when hypervelocity particles strike a surface. Material from the target is ejected on impact, boosting the momentum already imparted to the target by the impacting particle. Sensitive techniques to measure the added momentum, which depends on such factors as particle size and velocity, angle of impact and target material, will be developed at the facility, Keaton said.

"We'll be working on technical developments, such as improving the particle injection mechanism, the target chamber and all the electronics, and scientific research involving impact dynamics and measurements," he said.

The momentum of speeding particles is determined by applying conservation-of-energy formulas to precise measurements of the charge and time of flight in the vacuum. The results obtained at Los Alamos so far agree with earlier findings at less powerful accelerators at universities in Germany and England.

Although the particles are travelling at extreme velocities, stopping them is not difficult because of their small mass. That doesn't mean that the particles don't have any effect on the target, however.

"Such 'cosmic dust' or micrometeorites in space could create problems for a space station with a 20-year lifetime by slowing it slightly or pitting exterior surfaces, including windows," said Keaton, "The work here will help researchers understand the physical mechanisms involved in such high-velocity impacts."

Taking Off the Fat With Home Computers

Here's a project that should make a lot of people happy. Some day in the not too distant future, volunteers in diet studies may be able to weigh and record electronically what they eat at home, and then end the data over a computer to a laboratory for analysis, according to a scientist with the U.S. Department of Agriculture.

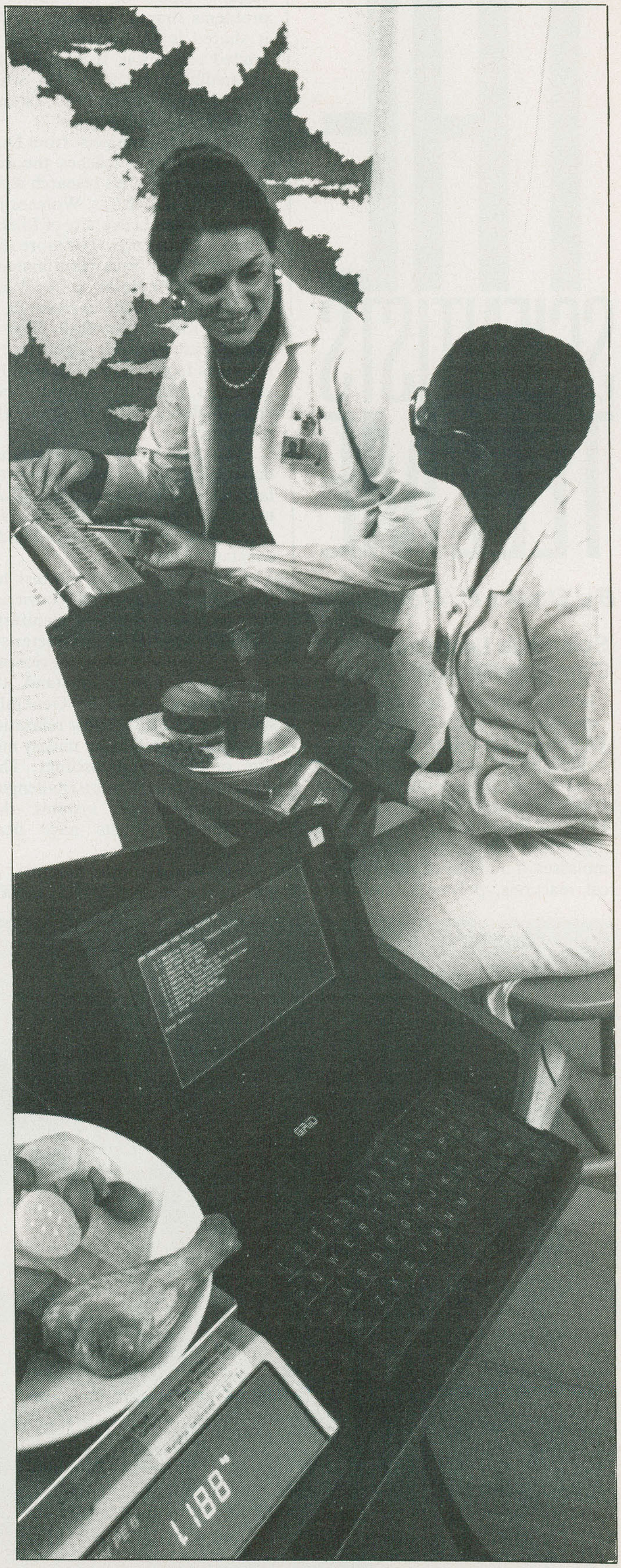
"If we can gather more precise data, then we should have a more accurate picture of whether people are getting the nutrients they need to stay healthy and fit," says Mary J. Kretsch, a research nutritional scientist with the USDA's Agricultural Research Service.

With a new system Kretsch and colleagues have developed, volunteers record their food intake in their own homes on a portable computer. The computer is linked to an electronic scale which weighs the food, and to a barcode reader, similar to ones at supermarket checkout counters, which records the food's identity. The data can then be transmitted over the telephone to the research laboratory.

"Thousands of pieces of data are taken in a diet study," says Kretsch. "This new system will help volunteers record data immediately and send it to researchers. Volunteers will use special barcodes from a new barcode catalogue developed by Kretsch and colleagues to record the identity of most common foods, such as frozen and canned foods, fresh fruits, vegetables and meats. So far 21 volunteers in two pilot tests have already learned how to use the electronic package.

The system uses USDA's nutrient composition database, which can accurately calculate about 36 nutrients in a given food item. "The system is one of the major advances in determining dietary patterns in more than 40 years," states Kretsch, who is located at USDA's Western Human Nutrition Research Center in San Francisco.

She says the system may reduce chances of volunteers failing to record snacks and other foods they eat, and will also make it cheaper, faster and easier for researchers to detect unhealthy diet trends. At times in earlier studies some data on meals would be missing. Volunteers may have forgotten to write in food diaries what they had eaten, or may not have remembered every item in face-to-face interviews.



USDA scientist Mary Kretsch (left) instructs dietary study volunteer in the operation of computerized food scales ■

Lisp for the Mac

Texas Instruments has introduced the micro-Explorer workstation, consisting of TI's processor peripheral plugged into a Macintosh computer. The combination becomes a powerful AI computer, allowing advanced symbolic processing techniques. The processor is compatible with the Explorer family of AI software. Systems start at $14,995 (US), including a Mac, 40M disk, a total of six megabytes of memory, and software. Versions are available for those who already have a Mac. For more information, contact Texas Instruments Inc., Data Systems Group, PO Box 181153 DSG-179, Austin, Texas (512) 527-3500.

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The Return of Analog?

Today's digital technology may be unable to deliver the signal processing speeds required to realize one of tomorrow's electronic dreams: a global computer network with virtually instantaneous exchange of information. However, researcher John Choma Jr of the University of Southern California has redesigned an old-fashioned analog circuit that economically processes signals hundreds of times faster than either digital or traditional analog circuit, something like winning a race with a horse that's long been out to pasture.

Analog circuits can process signals up to 7 billion times a second, but were largely displaced by digital techniques because they suffer from loss of signal quality, high power dissipation and large size. Now that digital circuitry is running into a speed barrier, the industry is taking another look at analog. Unfortunately, analog research is in a shambles, with nearly all present designers having been trained in digital techniques.

Professor Choma redesigned a conventional analog processor to reduce power consumption and increase speed. The key to the design is an innovative feedback scheme that uses additional transistors to effectively cancel the charge stored in the signal processing transistors. The new circuit will use more chip area, but this is not a problem since far less transistors will be required than for the equivalent digital circuitry. Professor Choma acknowledges that there is an extra manufacturing cost inherent in maintaining the signal quality in analog circuits, and he is conferring with representatives of the IC industry towards solving the problem.

Pathetic Pirates

In a recently filed lawsuit, Business Recovery Systems, a Colorado software manufacturer, alleged that a Rochester firm had illegally copied their disaster recovery planning software and documentation. The U.S. Marshal's office executed a seizure order and discovered the illegal copies.

The reason that they went ahead with legal proceedings is this: the Rochester firm borrowed the software, then returned it; unfortunately they left attached to it a routing memo, which read "Have copy of book and disk. It can be sent back."

Fastest Transistor

IBM scientists at the Yorktown Heights, NY, research facility have made and designed a transistor that has a 7 picosecond switching time, about twice as fast as the previous record for silicon. This makes silicon a match for gallium arsenide; the fastest gallium arsenide transistor to date has a switching time of 5 picoseconds.

The silicon transistor's speed was made possible by ultra- thin (tenth-micron) lines, and cooling the unit with liquid nitrogen. IBM points out that many complex problems must be solved before entire chips can be made that take full advantage of the small size and great speed of the new transistors.

More on Speed

The entire world of technology and hi-tech manufacturing seems to be obsessed with speed. People pay thousands of dollars for equipment to shave a few seconds off the operating time of their computers. Each month we receive press releases touting the fastest semiconductor ever made.

But do we really need this speed? Do we really need to shave a few seconds off?

Well, yes. The problem is human nature: we don't really need the computed results all that fast, but we hate waiting and looking at a blank screen while the computer cogitates. And, of course, you can't tear yourself away to go and get a coffee because you think you might miss something.

So here's the way to make the world's fastest computer, bank machine, or what have you: give the user something to do in the meantime. When AutoCAD regenerates your drawing, something which takes an eternity at least, the screen would pop up a tiny video game for you to shoot down Martians or something. Bank teller machines would play Trivial Pursuit while waiting to find out that the network is down. Police computers would give you a game of Marble Madness before telling you to pay $200 or go directly to jail.

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This year, over $1.5 *billion* worth of digital electronic music instruments—keyboards, guitars, drum machines, and related equipment—will be sold in the U.S. alone. Who's buying this new-tech equipment? Not just progressive musicians and professional recording technicians, but also thousands of people who have never touched a musical instrument before. And there's good reason why.

Something called MIDI (Musical Instrument Digital Interface) has suddenly transformed musical instruments into the ultimate computer peripherals . . . and opened up a whole new world of opportunity for the person who knows how to use, program, and service this extraordinary new digital equipment.

Now NRI's breakthrough Electronic Music Technology course puts you at the forefront of this booming new technology with exclusive hands-on training built around a MIDI-equipped computer, MIDI synthesizer, and MIDI software you keep.

Dynamic New Technology Opens Up New Career Opportunities for You

The opportunities are unlimited for the person who's trained to take advantage of today's electronic music phenomenon. Now you can prepare for a high-paying career as a studio technician, sound engineer, recording engineer, or road technician . . . even start your own new-age business providing one-stop sales and service for musicians, technicians, and general consumers alike. Or simply unleash your own musical creativity with the breakthrough training and equipment only NRI gives you.

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The Atari ST Series computer included in your course becomes the heart of your own computer-controlled music center. With its tremendous power, superior graphics capabilities, and built-in MIDI interface, the 16/32-bit Atari ST has almost overnight become the computer of choice for today's most knowledgeable electronic musicians.

The Casio CZ101 digital synthesizer, also included in your training, is the perfect complement to your Atari ST. The polyphonic, multitimbral CZ101—which stores up to 32 voices internally—"communicates" with your ST computer through MIDI, bringing life to virtually any sound you can imagine.

Plus, you get ingeniously designed MIDI software that opens up amazing new creative and technical possibilities . . . you actually build your own 4-input audio mixer/amplifier . . . and you test the electronic circuits at the core of today's new-tech equipment with the hand-held digital multimeter included in your course.

No previous experience necessary—in electronics or music!

No matter what your background, NRI gives you the skills you need to take advantage of today's opportunities in electronic music technology.

With your experienced NRI instructor always available to help, you master the basics of electronic theory step by step, gaining the full understanding of electronics that's now so essential for technicians and musicians alike. You move on to analyze sound generation techniques, digital logic, microprocessor fundamentals, and sampling and recording techniques . . . ultimately getting first-hand experience with today's explosive new technology as you explore MIDI, waveshaping, patching, sequencing, mixing, special effects, and much more.

Plus, even if you've never been involved with music before, NRI gives you enough basic training in music theory and musical notation to appreciate the creative potential and far-reaching applications of today's electronic music equipment.

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Uninterruptible Power Sources for Computer Installations

Total protection from power-supply disturbances for sensitive equipment and data.

By Dr. H. Virani

To most people, mains-borne electricity is a mysterious servant that responds instantly to their command. They insert a plug, turn a switch and receive instant light, heat and power for most of the things taken for granted in our daily lives. Even those of us who use sophisticated electronic equipment or instrumentation computers whether large or small, always assume it will be there, in unlimited quantities at our beck and call.

In the past, before the advent of the computers and other "real time" equipment on which we have become so dependent, it did not matter too much if there was a short break in the supply or that the power line was "noisy" or not exactly of the magnitude really required to obtain maximum reliability and efficiency from the equipment it was running. However, any user who has experienced any of these mains-borne-electricity-related problems, and has paid the cost in downtime, program errors, loss of data, production losses or equipment damage, will know only too well the frustration, time lost and ultimate monetary loss when this occurs.

An uninterruptible power supply (UPS) system is a device which is placed between the user's equipment input and the power-source output to act as a reserve source of energy in the event of a complete power failure.

But first we must establish the need for such equipment and having done so, select the appropriate product to meet the particular demands, of its application and environment. The user is buying insurance and therefore must make sure that when a claim is made the policy is a good one and provides for what it is intended, without hidden causes or conditions. The question is simply: Can I afford to be without my equipment? It does not matter if it is for a few milliseconds or some hours, the answer is the same in both cases (Fig. 1).

UPS Technology

There are basically two types of systems available to provide the reserve energy source: rotary and static UPSs. In addition there are two types of operating principles when considering each system: "outline" and "offline". Each type has its own advantages and disadvantages and these are outlined in the following sections.

Rotary Power Sources

The rotary power source (Fig. 2) is in essence an AC electric motor driven from the mains powerline or a rectifier supplied DC motor, shaft connected to an AC diesel generator which supplies power to the load.

Early systems incorporated a mains-failure detection circuit which triggered a start up sequence for the diesel engine, providing full power from the AC generator about 10-15s later. Later systems incorporated no-break flywheel systems, which attempted to maintain the generator speed for the 10-15s start-up time required for the engine, but suffered from poor frequency stability during the auxiliary-generator start-up period.

Refinements have since been made to these systems, and the more recent types use rectified DC to drive a solid-state inverter. The inverter output, which is more reliable, powers a synchronous motor generator set which in turn supplies the load. These systems have been used in many computer mainframe applications where power levels from 50 to 500 KVA are required.

In general, rotary uninterruptible power sources (UPS) systems are initially less expensive than static UPS in larger installations, but when considered in terms of performance, reliability, and maintenance they have proved to be less than satisfactory. Input power line noise isolation is poor, as there is capacitive and inductive coupling between the input windings of the motor and the output generator windings; the output voltage regulation capability is highly dependent on the input voltage remaining on or near nominal, and the "ride-through" capability over many line cycles, claimed from stored energy in the flywheel and rotating parts, is highly dependent on "dynamic braking" as the motor generator at power failure is still connected to the power source, and the attempts to feed the input and output simultaneously.

Static Power Sources

The first totally static power sources were introduced in the early 1960s, and as the same suggests, they have no moving parts (except cooling fans, when fitted). These originally very large devices used solid-state technology and in their basic form rectified the incoming AC power line into DC,

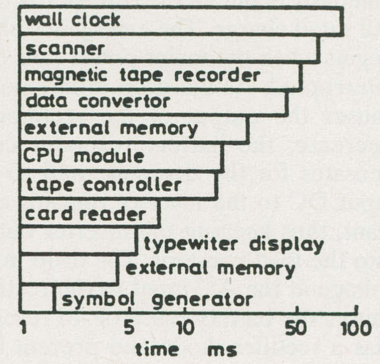


Figure 1

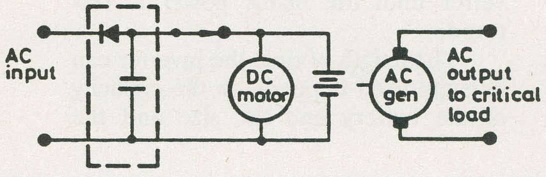


Figure 2

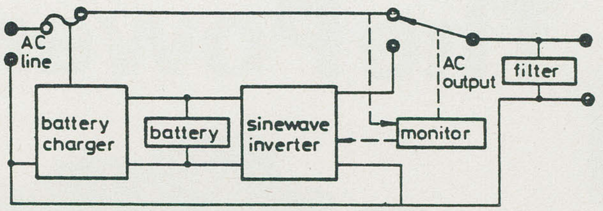


Figure 3

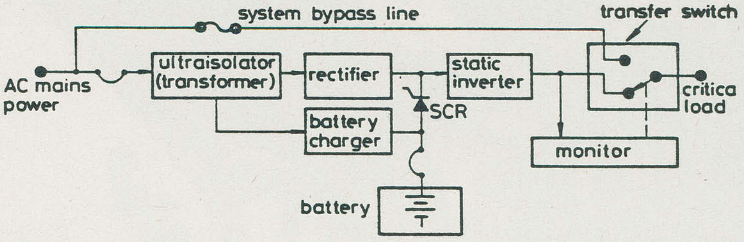


Figure 4

which in turn fed a solid-state inverter which changed the DC back into AC at the desired voltage and frequency, thus supplying the load. In the event of a main power failure a bank of batteries supplied the DC power to drive the inverter; the amount of time the load could be supported thus depended on the battery capacity and the load characteristics.

The batteries could be recharged by an external source when the mains power was restored or it could be a part of the UPS system function. A DC generator (with associated control circuits) could also be connected to the inverter to provide power after the batteries were exhausted.

From this basic system many techniques have been developed in the way in which they operate, and the three most common are referred to as:

- Continuous
- Forward transfer
- Reverse transfer

The continuous or online system, as the name implies, is always the final source of power for the load. The input of the uninterruptible power source is connected directly to the normal power line and the load receives power from the inverter output.

In contrast, the forward-transfer, or "offline" system (Fig. 3) is only connected to the load to provide AC power when it senses a fluctuation or interruption on the mains powerline.

The output of a reverse-transfer system, like that of the continuous online uninterruptible power sources, is normally connected to the load, but the load can be switched to a back up source — usually the mains power line — under certain circumstances. The online reverse-transfer system (Fig. 4) is that most commonly used in computer and other sensitive equipment applications, as it provides complete protection against all types of power line problems because:

- the input/output is isolated through the internal DC line and so removes all incoming power-line noise disturbances.
- serious voltage variations at the input will result in the internal batteries supporting the inverter-input direct voltage, and so the inverter output voltage will remain stable to the load, in the event of a complete mains failure the batteries will support the system.
- the output frequency from the inverter will always be within preset

limits as the inverter output frequency is controlled by an internal oscillator.

- other input-output protection can be easily incorporated within the design (over voltage, over currents, etc.)
- it provides for switching to an alternative power source in the event of a system malfunction or failure.

Solid-State Switches

The faster operation of the solid-state switch is especially important in applications where the load is sensitive to step load changes or voltage transients, and so it is generally preferred in computer applications.

However, the user should decide whether this feature is essential as the difference in cost between the two can be significant; there are other more general considerations which should also be taken into account, such as the type of inverter design used and its dynamic response characteristics.

UPS Operating Modes

There are three modes of operation for any UPS system: operate, emergency and recovery. In the reverse-transfer system most commonly used in computer applications as previously described, the modes occur as follows. In the "operate" mode as in the continuous system, the unit acts as a buffer between the mains power source and the load.

The rectifier and charger provide current to the inverter and simultaneously maintain the batteries at their full rated charge. The emergency phase begins when the mains power fails or is interrupted. As the drop in line power causes the output of the rectifier to decrease, the battery reservoir compensates for the decrease, and so the input DC to the inverter remains constant, thus keeping the inverter output into the load constant. The drop in the voltage at the AC input to the rectifier causes the battery reservoir to reverse-bias a rectifier diode and prevent battery current flowing back through the charger. The batteries support the inverter until the mains power is restored.

The length of time the inverter can be supported depends on the capacity of the battery and the size and the characteristics of the load. The "recovery" mode begins when the mains power returns to normal. At this time the rectifier and charger output is restored and begins to drive the inverter, taking over from the battery while at the same time starting to recharge the batteries. When the batteries are fully recharged the system returns to the "operate mode".

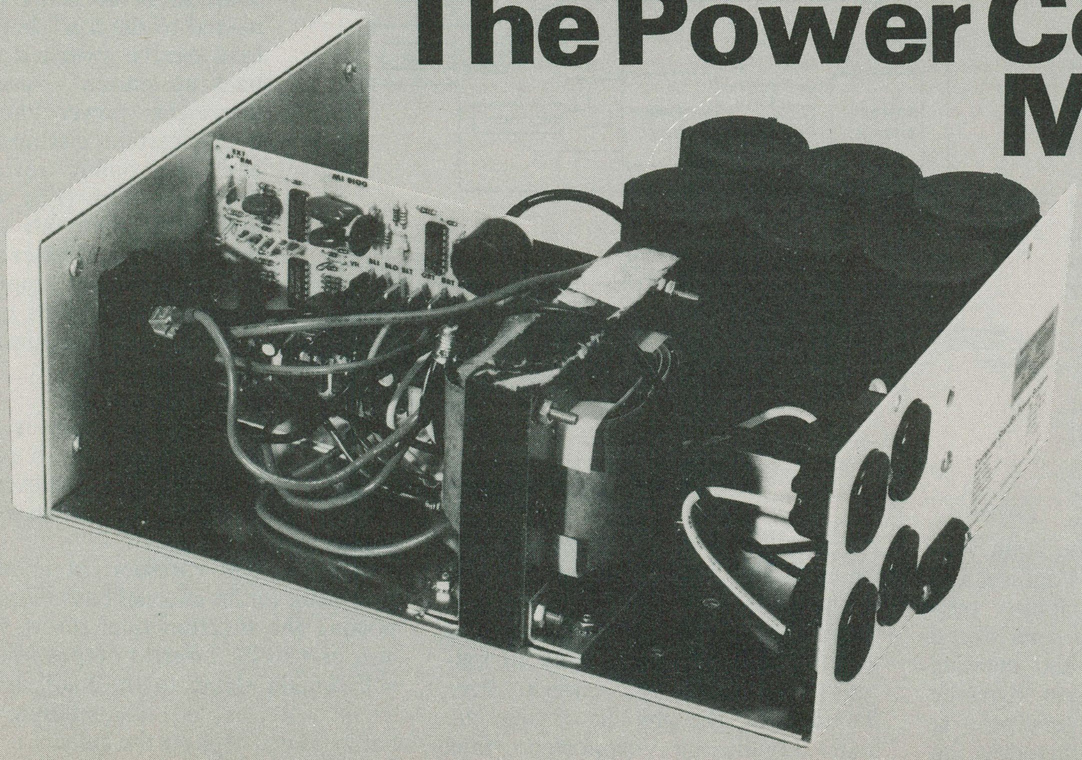
Generally speaking, a correctly sized charger will allow a complete recharge of the batteries within 10-16 h.

UPS System Element

The characteristics of each of the elements of the UPS systems can have definite effects on the overall system performance and while they are of prime concern to the systems designer, the potential user should be aware of them. The elements concerned are as follows:

- rectifier
- charger
- inverter
- transfer switch
- status monitors
- alarms

The Power Control ME-400 UPS



A Mini review of a UPS

By Bill Markwick

The rectifier should be capable of powering the fully loaded inverter continuously with minimum specified input voltage and should allow 120-150% of normal load to be applied for short durations (10s) with input voltages as low as 10% below normal. The rectifier should have input protection and be 85-90% efficient. The battery charger should be separately protected and have good efficiency.

The inverter determines the ultimate quality of the power that drives the load.

There are a number of concepts which have been developed, each type having certain characteristics which bear directly on its suitability for various applications. The type of inverter fitted into the UPS could be one of the most important factors considered as it is the most critical section of the complete system, and, should it fail, the UPS is instantly out of operation.

The purpose of the inverter is to change the direct voltage from the rectifier or the battery to pulsating DC, which in turn can be shaped and filtered to produce a sinusoidal voltage that meets the requirements of the load. This voltage must be of stable amplitude and frequency, contain a low percentage of distortion and be a clean wave form. The most commonly used inverter types are the ferroresonant inverter, the pulsewidth inverter and the quasi-squarewave inverter. Whichever type is used, it should have adequate input protection (fused and low voltage cutoff), be capable of providing the full rated power over various power factors, and have good static and dynamic regulation characteristics. The inverter output frequency in normal operation is synchronized with the mains supply and is kept within close limits when in the "emergency" mode. Harmonic distortion should be kept as low as possible in any condition of load and line.

The type of transfer switch required should be selected depending on the characteristics of the load to be supplied. Many systems feature internal and external alarms and functional status indicators, using lamps or LEDs on a flow-diagram principle. There appears to be great merit in such visual indication of correct or incorrect operation, as fault location and rectification is much faster and easier. Modular techniques are also widely available and contribute to ease of service and repair.

Conclusion

In the end, however, the requirements of each uninterruptible power sources system should be evaluated individually, because site and load requirements are seldom the same.

Initially, each individual load at the site should be analyzed to establish which are critical, which are essential and which are nonessential. Critical loads must have reliable power to prevent damage or dangerous operating conditions. Essential loads, must operate acceptably during short or prolonged mains power failure. Categorizing the loads and their profiles makes it easy to determine what needs protection, and installing a suitable, correctly specified uninterruptible power sources system will ensure that the insur-ance policy, when needed, will pay out. ■

In our Uninterruptible Power Supply article on the preceding pages, Dr. Virani discussed the theory and selection of the devices. Here's a look at an actual UPS, the Canadian-made ME-400 by POwer Control Incorporated of Toronto. It's a small metal cabinet measuring about 4" by 9" by 12"; on the front is a power switch and status LEDs, and on the back are four power outlets and a line cord.

The unit to be protected from power interruption is plugged into the back of the ME-400, which is itself plugged into a standard outlet. Up to three more pieces of equipment can be added to the rear outlets as long as the total power drain does not exceed 400 watts. Surge and spike protection is built-in and the unit is totally silent when the AC is on.

In the event of a power failure, the ME-400 takes over, sounding an alarm beeper and giving you ten minutes (at the full 400W) to save your files and power down. When the AC is restored, the ME-400 goes into the charge mode, reaching a full charge in four hours.

The ME-400 costs $1000. Optional equipment includes another battery pack to extend the operating time to 20 minutes.

In Use

We tried the ME-400 with a variety of small and large computers (and, of course, the light bulb on the cover). We tried switching a power bar on and off as well as yanking the plug out of the wall; there was never so much as a glitch from the computers, and we could power them down successfully every time. The output waveform did cause small lines to roll down the monitor screen, though they didn't interfere with operation in any way. Interestingly, these lines did not appear with the plasma screen of the Toshiba laptop computer.

When the power is cut, there's a slight hum from the unit as the oscillator takes over, followed by a regular beeping from the alarm. The changeover occurs in less than 2 milliseconds, enough top cause a tiny flicker from the light bulb that we had plugged in, but not enough to disturb any computers that we tried. The red LED comes on to let you know that you're in the battery- supported mode.

When the power is restored, the green LED lets you know that the AC is back and the batteries are charging.

Inside

The ME-400 battery pack consists of six maintainence-free gel- type cells. Beside it is space for a second pack, which gives you the ME-410, with 20 minutes of time. The battery output is switched by a bank of transistors to produce a squarewave, which is then stepped to line voltage level by the hefty transformer. This transformer also serves to charge the battery when the AC is restored. An external alarm can be connected. The output is protected with a 4A circuit breaker, and everything is CSA approved.

There are also models with 800, 1200 and 1500 watts output, with duration dependent on battery configuration. Other uses include backing up electronic telephone systems and instrumentation. ■

Circle No. 42 on Reader Service Card

A Visit to Trebas

A look at the Canadian institute for training in the recording arts.

By Bill Markwick

In the late 70s, David P. Leonard was working in the music and recording business in Montreal, managing artists, studios and recording labels. He asked himself, as did many in the Canadian industry, why many major artists immediately headed south to the US for the production of records and soundtracks. After all, he reasoned, we have the very best of state-of-art equipment and facilities here in Canada. The answer had to be the lack of trained support personnel: the engineers, technicians and producers that have to work with the artists in a proper blend of technology and art.

Since he had worked in developing technical and management training for various major industries both in the US and Canada, and as a communications consultant, David decided to open a training school to turn out the people he felt the recording industry needed, and so in 1979 he opened the Trebas Institute of Recording Arts in Montreal, the first of five locations. The name, of course, is from treble-and-bass, "spanning the spectrum of music and audio technology".

There are now campuses located in Montreal, Ottawa, Toronto, Vancouver, and Los Angeles. A Canadian-owned school teaching recording engineers in LA is an interesting reversal on the situation mentioned above.

Toronto

The Toronto division of Trebas is located in a large renovated house downtown at the corner of Dundas and Berkeley streets, in an area that's an eclectic mixture of Edwardian houses, rebuilt office buildings and the occasional factory. The first floor of Trebas consists of offices and a few classrooms, renovated not in the usual white-space-and-tracklights, but subdued colors with much of the original woodwork intact.

The second floor has more classrooms and the third has a large elegant student lounge ("probably the only student lounge with a Jacuzzi"). There's a small library, well-stocked with material relevant to recording and the physics of music. In the basement is the small 16-track recording studio and workshop. The studio, while it has everything needed to demonstrate the basics, is not used for training in full-scale sessions; in this case Trebas rents blocks of time at major 24-track studios in the area.

The atmosphere is friendly, busy.

The equipment is first- rate, including some advances in recording and recording studio technology which we'll come back to shortly.

The Course

The Trebas course consists of four terms which can be completed in less than two years on a full-time basis. Each term is at least ten hours per week of supervised instruction over fifteen weeks, with the entire program being at least 600 hours in length. The student puts in two to four hours of personal study for each hour of personal instruction. Part-time courses are also available, letting students complete the entire program with less than the full course load at one time. The graduation certificate requires a C average, corresponding to 70-79%.

First Year

The first year consists of twenty topics. A random sampling of these: Communications Principles, Music Theory, Ear Training, Record Producing, Sound and Recording, Multi-track Recording, Environmental Acoustics, Management, and Industry Professionals Seminars.

The theoretical instruction and workshop practice is bolstered by the guest lectures and seminars. Guest lecturers have included recording-industry "stars" like Tom Dowd (Rod Stewart), Bill Porter (Roy Orbison, Everlys, Presley), and Phil Ramone (everybody). There are also lecturers from the technology side of the industry, speaking on hardware, acoustics, etc.

Second Year

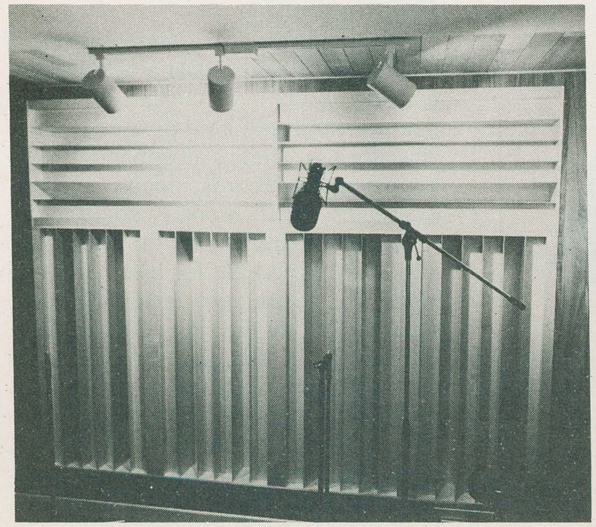
There are many more topics in the second year, grouped into three areas as Record Producing, Engineering Technology and Management. The recent prominence of the computer in electronic music is covered in electronic-music labs, with explanations of how the basic building blocks of the synthesizer work, plus the ubiquitous MIDI interface system. Malcolm Cecil of the Record Plant, who has produced, engineered and performed on numerous hit records of major artists like Stevie Wonder, has been appointed instructional specialist to design a number of courses for Trebas, including Computers in the Music Industry. Other important topics include The Visual and Aural Image, Video and Audio Systems Analysis Arranging and Orchestration, Contracts, Copyright, Digital Audio Engineering, Video Recording, Managing, Accounting, Record Distribution and many others.

There is also emphasis on hands-on electronics, at least at the level you'd need for studio work. I don't think I ever met anyone working in a studio who didn't at least understand the basics of amplifiers, power supply wiring, grounding, etc. Even the Top Brass could solder up a 25-pair cable if they had to.

The Studio

Up to 1985, Trebas staff found themselves renting recording studio facilities to the tune of 4,000 hours per year. They decided that if they designed and built a small studio in their building, they could reduce rental time and provide an in-depth student involvement at the same time. The students prepared the budget, constructed the room, installed the equipment, tested the acoustics and outlined management of the studio (similar arrangements have been made for the other Trebas sites).

The internal facilities are used to familiarize students with the basics of the console routing, tape machine operation, microphones, and so forth. The teaching



A view of the studio control room, showing the electronic keyboards, console and audio/video monitors. (Inset) The reflection-free zone created by the special panel, which was designed and patented by Dr Peter D'Antonio.

of large-scale recording sessions is still done at rented 24-track facilities.

The tape machine is a Tascam 16-track with 1" tape, an economical format that can be used to demonstrate almost all the functions of multi-track recording. The console is a Soundcraft, a flexible unit with most of the features required for most studio work. The monitors are KEF units mounted in the acoustical corners of the room; this placement allows performance equal to that of much larger speakers.

The space for the actual recording area was limited, and one of the big problems in miking a small space is the harshness of the reflections, something that will be familiar to anyone who's made a hollow, boomy home recording. One of the usual cures is to line the room with absorbent material, but this is bulky and often causes a muffled, bass-heavy sound. Trebas used a unique, patented wall panel designed by Dr Peter D'Antonio to produce a reflection-free zone on one wall. The panel consists of a number of horizontal baffles arranged in a precisely-calculated pattern; the acoustic cancellations produced by the panel's phasing gives the effect of a much larger room without objectionable tampering with the frequency spectrum. I spent only a short time in the studio, but the bounce effect from voice and handclaps was very smooth and lacked that oppressive, disorienting feeling that often happens with absorbent rooms (the feeling that your voice stops two inches from your nose).

In the control room, the studs to hold the panelling have been installed on varying centres to minimize resonance, and certain panels have been left flexible to absorb bass energy. There's the usual complement of video equipment, monitors and electronic keyboards. Despite the standard array of electronic modules, MIDI hookups and computers, the Trebas staff emphasized that they also concentrate on teaching proper miking and EQ of acoustic sources. After all, acoustic guitar players don't want their guitars to sound like a Marshall amp eight feet wide. Well, they do, actually, but only for a giggle. Mixers and engineers have to be able to get a natural acoustic sound when required.

Employment

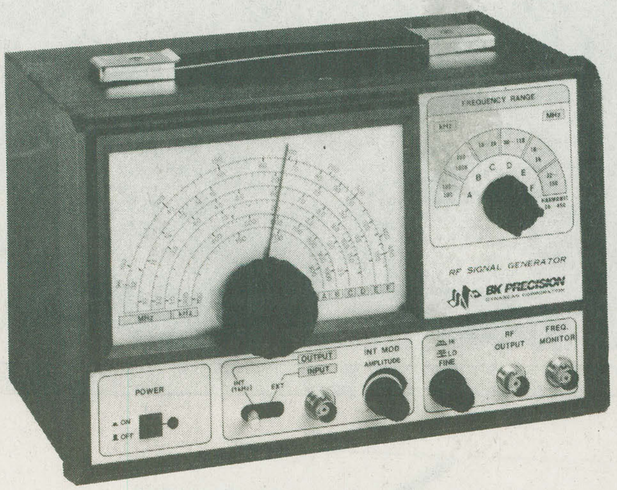
On the positive side for those thinking of a career in the recording arts is the fact that the media have created a demand that no one would have thought possible 20 years ago. There's an apparently endless lineup of records, videos, commercials, films and TV work. Needless to say, to be a good mixer takes far more these days than a good ear for bass, mids and highs; the technology is getting more sophisticated all the time. On the negative side is the fact that the industry is seen as glamorous (which it is, I suppose) and good AV people become subculture stars. This draws an enormous number of applicants for a limited number of positions that have a fairly low turnover rate. To be fair to the new applicant, it's entirely possible that you may have to be a tape jockey for a long time until it's your turn in the control room spotlight.

But then again, I'll bet that last somewhat negative comment won't mean a thing to the determined. If you feel cut out for AV production and you want an efficient way to absorb the new art and technology, Trebas is well worth investigating.

Locations:

Montreal: (514) 845-4141
Ottawa: (613) 232-7104
Toronto: (416) 966-3066
Vancouver: (604) 872-2666
Los Angeles: (213) 467-6800 ■

NEW PRODUCTS



150MHz Signal Generator

B&K announces the new Model 2005 RF Signal Generator, capable of a frequency range from 100kHz to 150Mhz fundamental frequencies, and up to 450MHz on harmonics. The output level is 100mv with a 20dB level control. An internal amplitude modulation control at 1kHz is continuously variable from 0 to 100%, plus external modulation capability is provided. B&K is represented in Canada by Atlas Electronics, 50 Wingold Ave., Toronto, Ontario M6B 1P7, (416) 789-7761.

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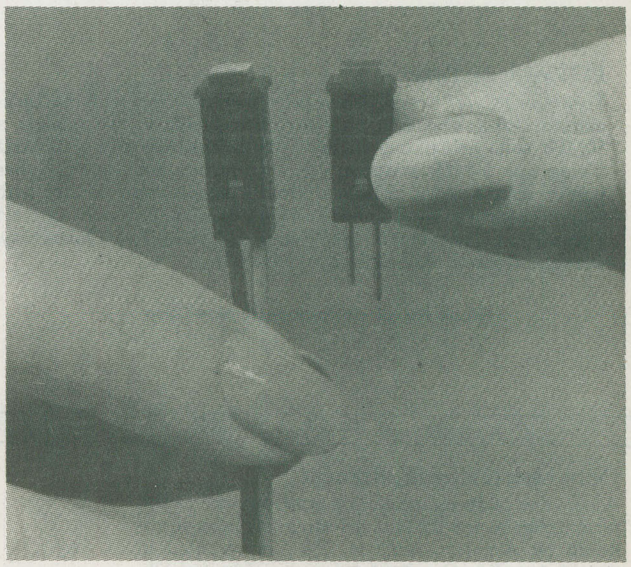

Square, Snap-in LED

Square, snap-in LEDs are now available from Dialight dealers. The 559 Series Square LED Indicators are suitable for a wide variety of applications, and provide wide-angle visibility because of the shape. No additional hardware is required; the LEDs mount in .218" holes on .300" centres. The red, yellow or green units are mounted in black housings. The name of a local supplier can be obtained from Dialight Corporation, 1913 Atlantic Avenue, Manasquan, NJ 08736, (201) 223-9400.

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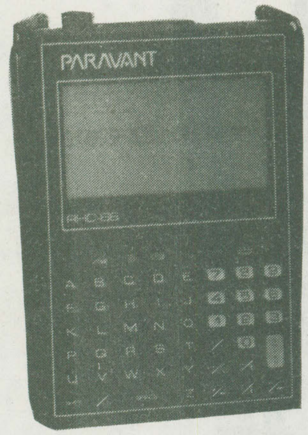

Handheld MS-DOS

Paravant introduces the RHC-88, a 4.5 pound MS-DOS computer with military-standard ruggedness for use in even the harshest environments. The processor is 8088/8086 compatible; the operating system is MS-DOS 3.2 in 128K of ROM. Main memory is 512K of RAM expandable to 1MB. Programs are stored in 192K of programmable ROM. The 5" by 2.75" LCD screen provides a 16 line by 42 character text mode and a 256 by 128 pixel graphics mode. Data is transferred in and out with a high-speed optical port. The unit is powered by NiCads, C-cells or an AC adapter. Many other options are available. The RHC-88 lists at $3995 (US). Contact Paravant Computer Systems, 7800 Technology Drive, Melbourne, Florida 32904, (305) 727-3672.

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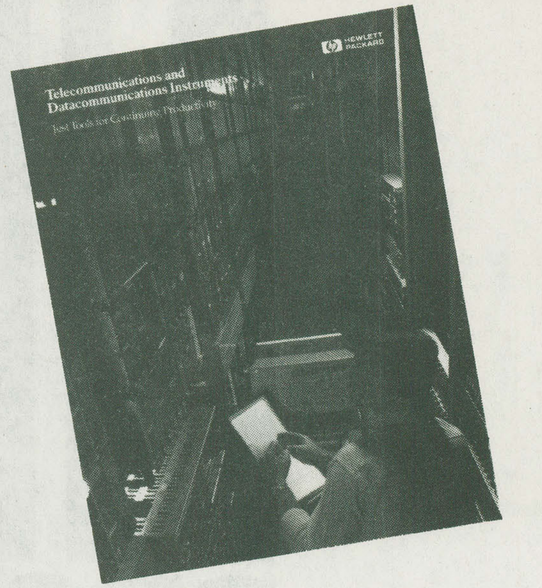

Telecom Catalog

Hewlett-Packard announces a new catalog with information on more than 90 test instruments for operators, users and manufacturers of telecommunications or datacommunications equipment. Contents include test gear for digital/analog testing, various types of transmission, microwave and satellite, cellular radio and more. The catalog, number 5954-6926U, is available without charge from HP. Hewlett-Packard Canada Ltd., 6877 Goreway Drive, Mississauga, Ontario L4V 1M8, (416) 678-9430.

Circle No. 19 on Reader Service Card

PC Logic Analyzer

Turn your PC, AT or compatible into a logic analyzer with the Techmatron Pc/La. This is a plug-in card available in two models, a 50MHz state and timing version with 32 channels and a 100MHz timing with 50MHz state analysis. The menu-driven interface has pop-up menus and a Help key. More channels can be added with plug-in cards. The basic unit is $2,495 (Canadian, FST out). Contact Techmatron Instruments Inc., Suite 111, 833 The Queensway, Toronto, Ontario M8Z 5Z1, (416) 251-6671.

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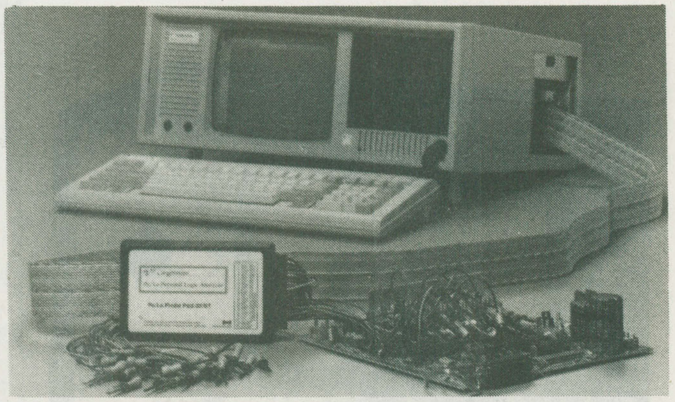
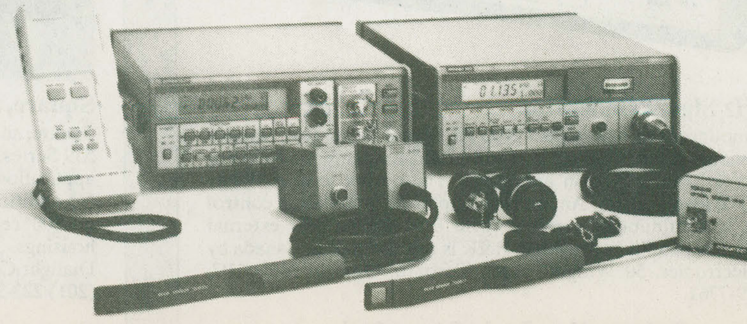


Opto Measuring Equipment

A new line of seven measuring instruments and systems designed for R&D and testing has been introduced by Avantest America, INc., represented in Canada by Allan Crawford Associates. The new line includes instruments for basic measurements of wavelength of light emitted by laser diodes and LEDs, as well as equipment used for high-precision and high-speed measurement. The complete line focuses on the growing applications of optoelectronics in communications, information processing, audio, medical and industrial equipment. For more information, contact Allan Crawford Associates Ltd., 5835 Coopers Avenue, Mississauga, Ontario, L4Z 1Y2 (416) 890-2010.



Circle No. 21 on Reader Service Card

Interference Filter

The Model 6515 notch filter from the Microwave Filter Company eliminates broadband transmitter sideband interference to VHF receivers at the same site. The unit is installed at the output of the transmitter; notch frequency is 47.005, with other frequencies available. Notch depth is 112dB minimum. Power handling is 10kW CW. For more information, contact MicroWave Filter Co., 6743 Kinne St., East Syracuse, NY 13057, (315) 437- 3953.

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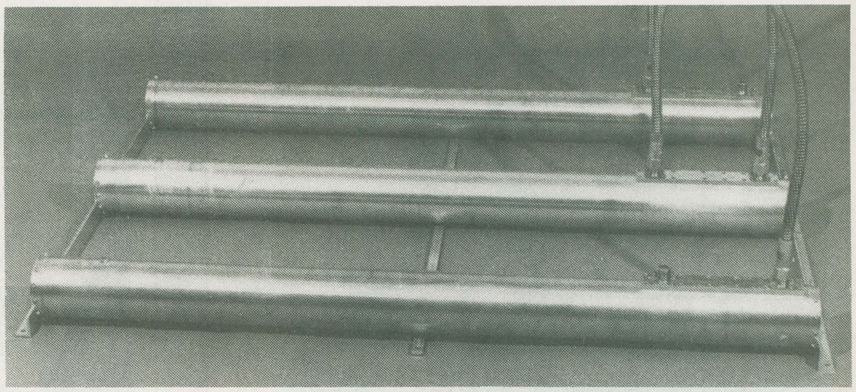

Function Generators

Brunelle Instruments has been appointed the exclusive Canadian sales representative for the Newtronics company. Eight different models of high quality Newtronics function generators are available, and the most popular model, the 200 series, features high frequency setting accuracy, external frequency measurements to 100MHz, environment compensated response analyzing, and precision start/stop. For more information, contact Brunelle Instruments Inc., 73 6th Range S., St Elie d'Orford, Quebec J0B 2S0, (819) 563-9096.

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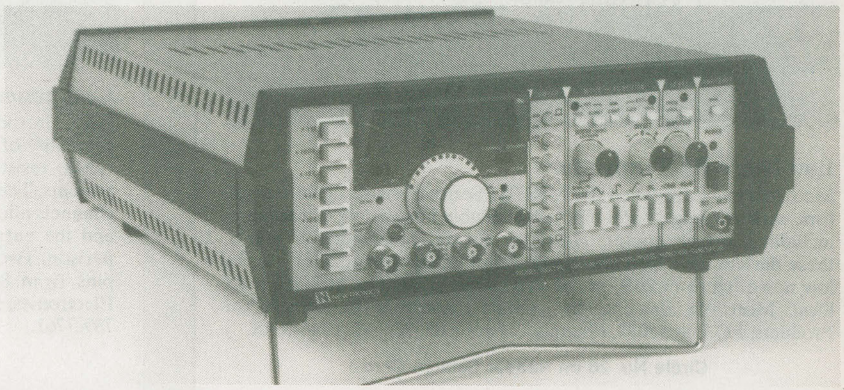

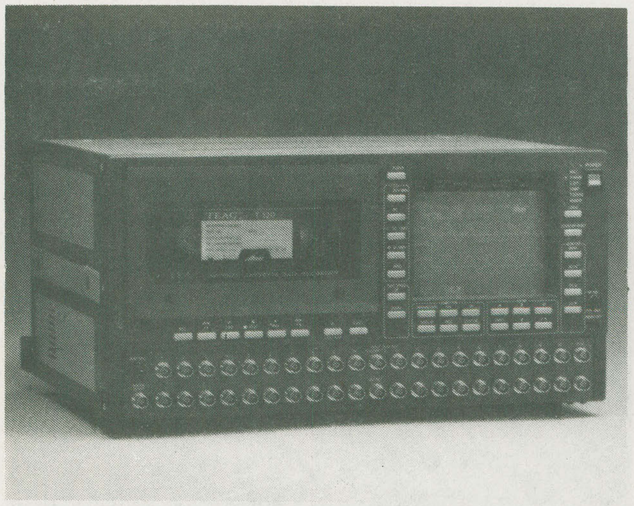

Data Recorder

TEAC announces two portable data recorders, the 14-channel model XR-5000 and the 21 channel XR-7000. Both recorders feature a large CRT display that has user-selectable modes for bargraph or waveform configuration. ID information such as title or timecode can be recorded and played back to identify recording conditions. A standard VHS cassette tape is used to provide up to 5 hours and 44 minutes of recording time. Since these recorders feature the Group 1 x 2 recording format, a frequency response of DC-40kHz is standard. For more information, contact Metermaster Division of R.H. Nichols Co. Ltd., 80 Vinyl Court, Woodbridge, Ontario L4L 4A3, (416) 851-8871.

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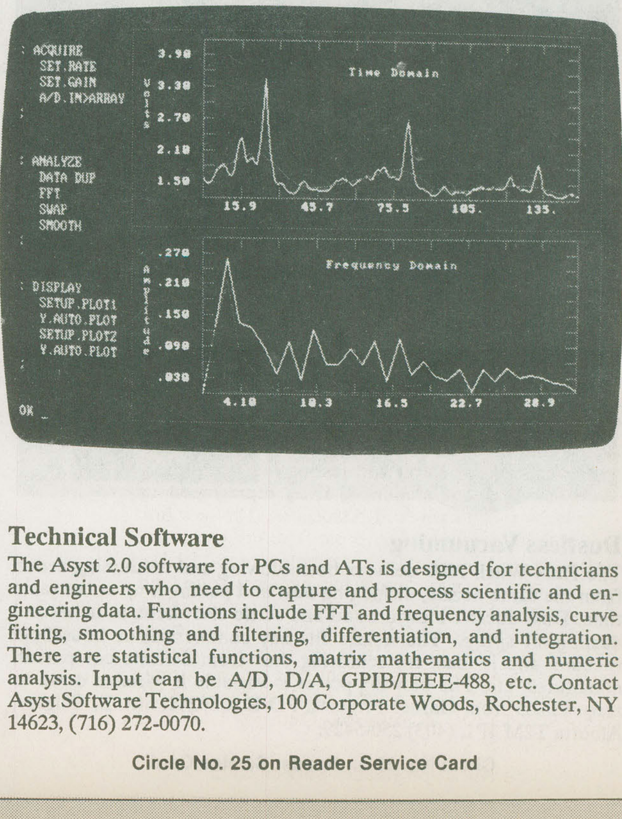

Technical Software

The Asyst 2.0 software for PCs and ATs is designed for technicians and engineers who need to capture and process scientific and engineering data. Functions include FFT and frequency analysis, curve fitting, smoothing and filtering, differentiation, and integration. There are statistical functions, matrix mathematics and numeric analysis. Input can be A/D, D/A, GPIB/IEEE-488, etc. Contact Asyst Software Technologies, 100 Corporate Woods, Rochester, NY 14623, (716) 272-0070.

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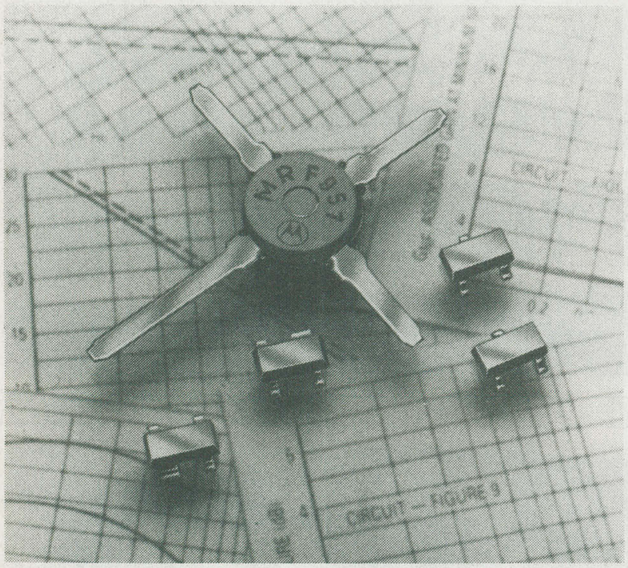

Low Noise RF Transistor

Motorola has introduced the MRF951 Series of small signal transistors, with low-noise NPN bipolars available in a variety of packages, including surface mount. Having a current bandwidth of 8GHz, these devices have high associated gain (12.5dB typ. at 2GHz) and a low noise figure (1.2dB typ. at 1GHz and 1.7dB typ. at 2GHz). At local Motorola dealers, or contact Motorola Semiconductor Products, PO Box 52073, Phoenix, Arizona 85072, (602) 244-3818.

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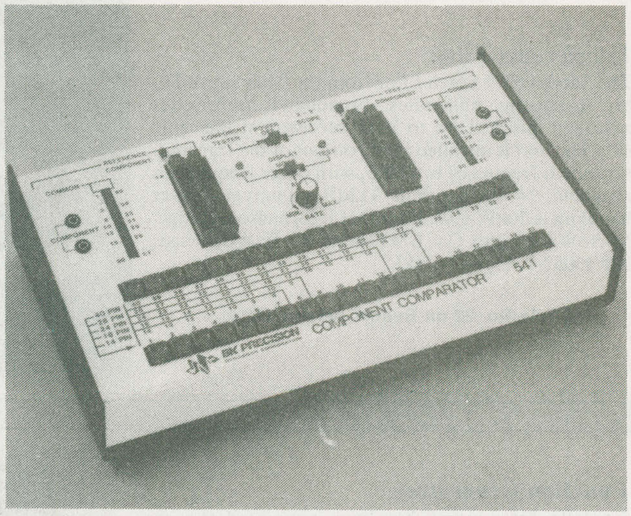
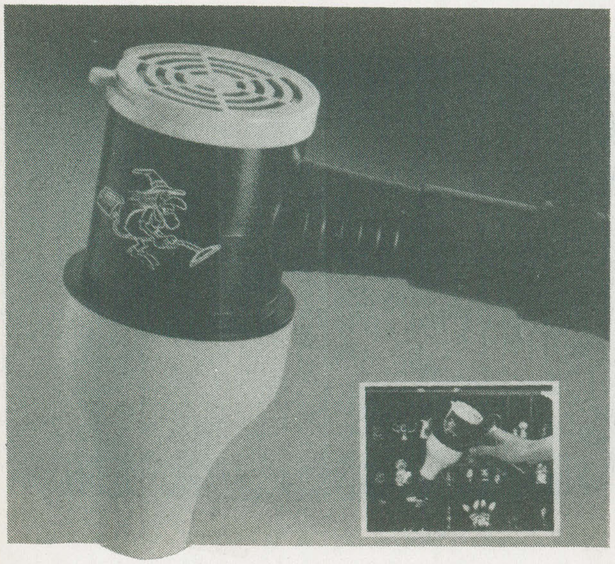


Component Tester

B&K introduces the Model 541 component tester, with the capability of testing ICs up to 40 pins. It generates a test signal to check resistors, capacitors. inductors, diodes, and other components. The VI curve is output for display on any oscilloscope. Two channels allow comparing an unknown component with a good one, and the output can be switched between channels for direct comparison. Two 40-pin ZIF sockets test the impedance signature of IC pins from 8-pin to 40-pin. The 541 also tests in- circuit. Atlas Electronics, 50 Wingold Avenue, Toronto, Ontario M6B 1P7, (416) 789-7761.

Circle No. 27 on Reader Service Card



Dustless Vacuuming

The Dust-Witch 2000 delivers both blowing and vacuuming action from the same nozzle, dislodging dust and pulling it up at the same time. Dust doesn't blow around and settle elsewhere, as in aerosol dusting-off sprays. The nozzle fits any commercial or household vacuum, and is ideal for removing dust from delicate equipment, miniatures, etc. The blowing power is variable is variable down to zero. $33.65 from Garnet Projects, PO Box 30241, Stn. B, Calgary, Alberta T2M 4P1, (403) 250-5429.

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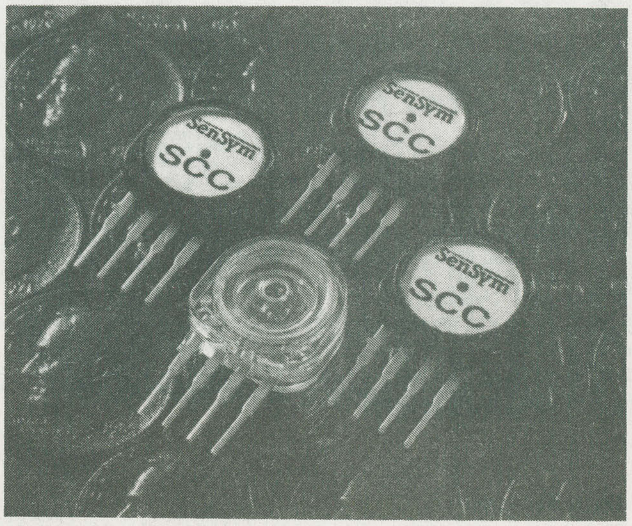

Pressure Sensors

If you're looking for small, solid-state pressure sensors, the SCC series from Sensym features low-cost, temperature stable units. Three devices are available from 0-5PSI to 0-30PSI. The devices are packaged in a four-pin SIP. Combined linearity, hysteresis and repeatability is less than 0.5% FSO. The price is under $10 (US) in single quantities. For more information on sensors, contact Sensym Inc., 1255 Reamwood Avenue, Sunnyvale, California 94089, (408) 744-1500.

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Super VHS Recorder

JVC announces the Super VHS HR-S7000 videocassette recorder. With a horizontal resolution of over 400 lines, the new format exceeds the quality of the broadcast signal. Super VHS does this by recording the luminance signal in a broader and higher carrier frequency band, from 3.4-4.4MHz to 5.4MHz-7MHz. The broadening of the bandwidth from 1MHz to 1.6MHz and the use of a nonlinear sub-emphasis has resulted in improvements to the signal to noise ratio. Audio dynamic range is better than 90dB. The HR-S7000 also features automatic switching to standard VHS when required during recording or playback. At JVC video dealers, or contact JVC Canada Inc., 21 Finchdene Sq., Scarborough, Ontario M1X 1A7.

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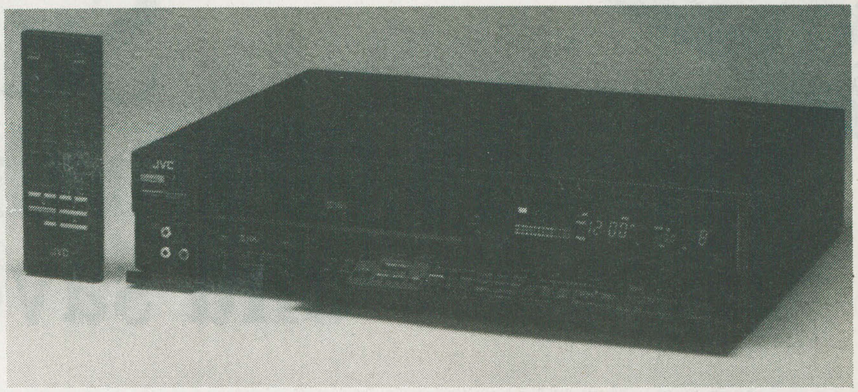

Low Ohms Meter

Megger has just introduced a new portable low resistance ohmmeter, the D203 to its Ducter product line. The new model automatically compensates for thermal EMF effects, both constant and varying. This means that readings are faster and more accurate, since there is no need to wait for thermal stability. The eight full-scale ranges, from 199.9 micro-ohms to 1999 ohms, give resolution down to 0.1 micro-ohm on a 3 1/2 digit LCD. The Ducter D203 can be operated on 120VAC or via internal rechargeable batteries. Contact Metermaster Division of R.H. Nichols, 80 Vinyl Court, Woodbridge, Ontario L4L 4A3, (416) 851-8871.

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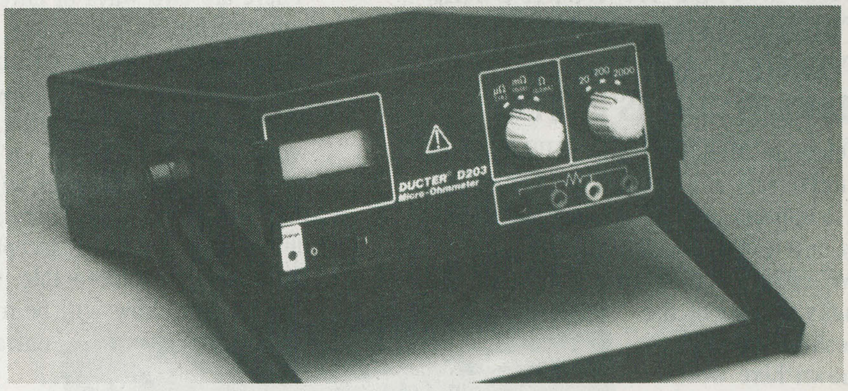

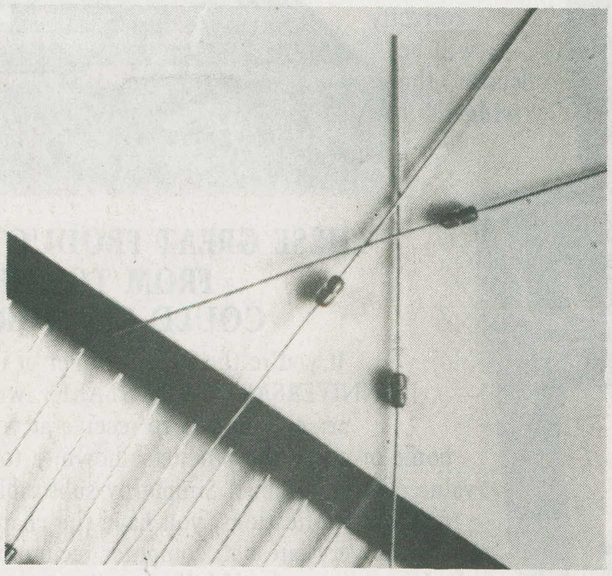

NTC Thermistors

Fenwal Electronics announces the release of its interchangeable, curve-matched NTC thermistors, the Uni-Chip Series II. These are low-cost, hermetically sealed, glass-encapsulated units. They are designed to cover the full temperature range of 0 to 100 degrees C, continuous use. Five standard values from 10k to 100k ohms are offered. Contact Fenwal Electronics/American Power Devices Sales and Applications, 450 Fortune Blvd, Milford, Mass. 01757, (617) 478-5255.

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Powered Speakers

For those who just can't get them large enough or loud enough, Altec Lansing is offering the Model 550, a pair of six-foot speakers with five amplifiers each, for a total of 1400 watts. A remote control allows adjustment of the ten amplifiers to suit room acoustics. For $18,000 (US) a pair, you can really make the dog howl or break the lease. At Altec dealers, or contact Altec Lansing Consumer Products, Milford, Pennsylvania 18337.

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Continued on page 62

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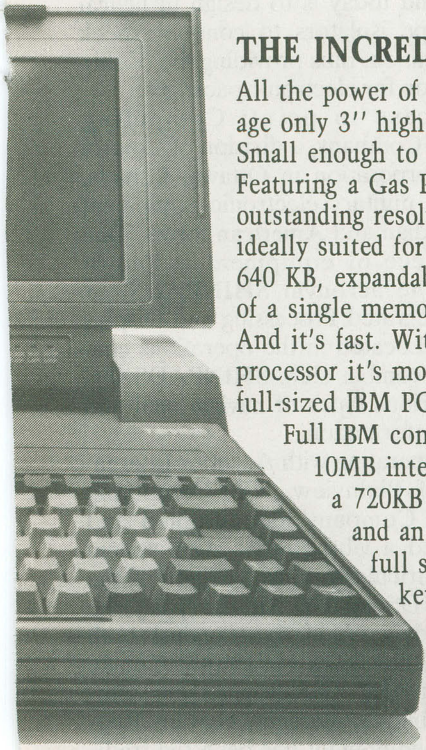

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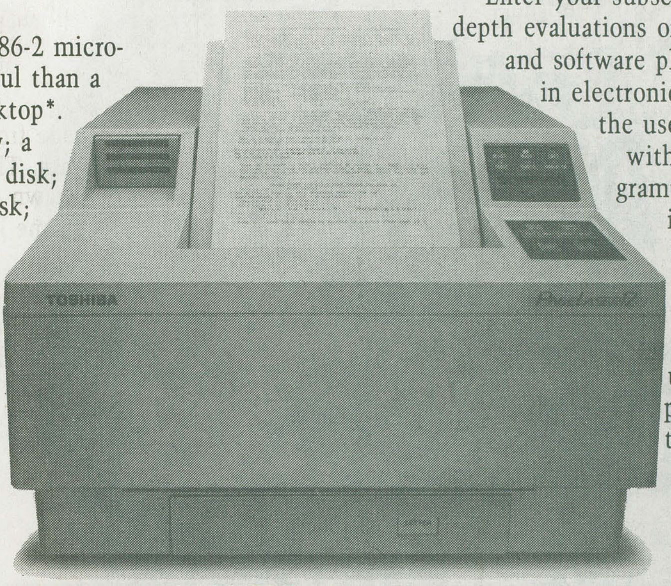

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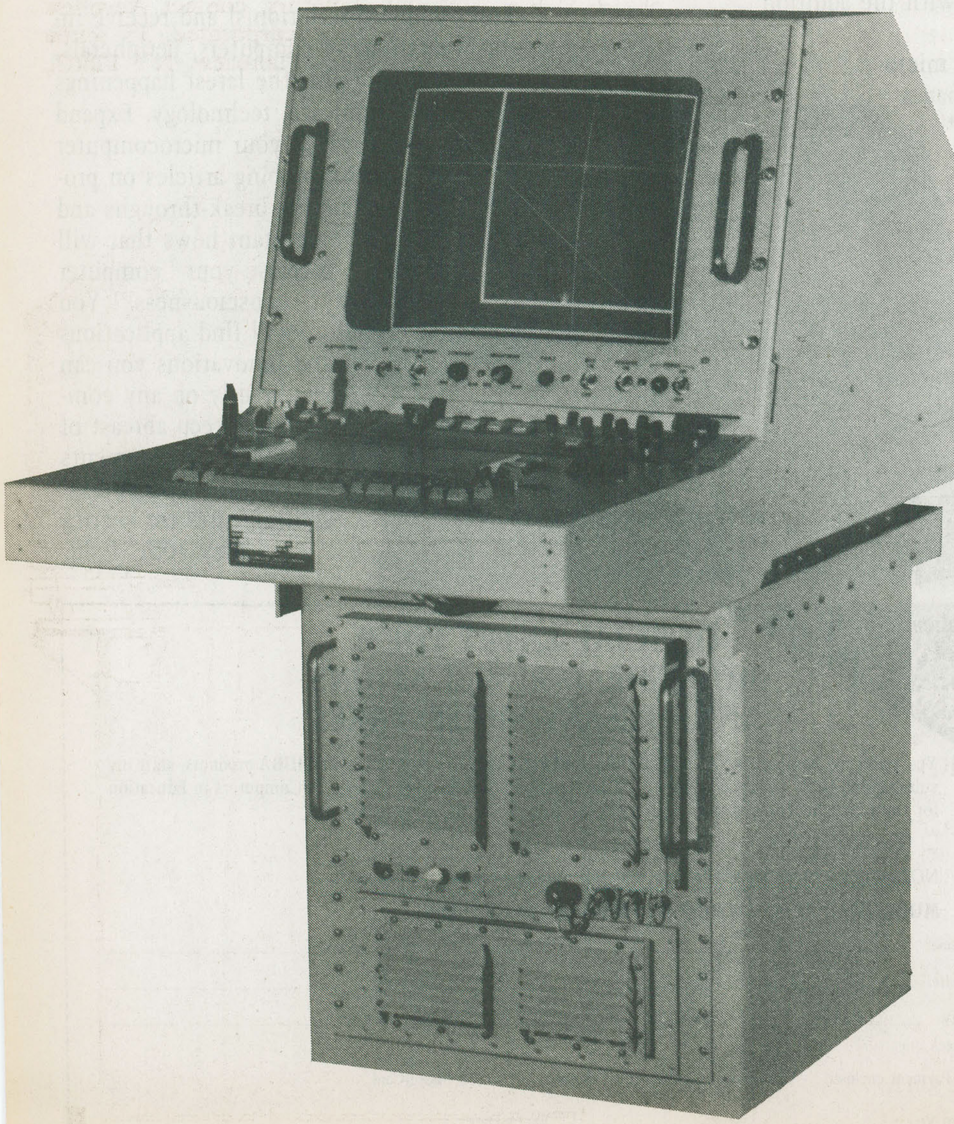
Unique Shockmounting for Electronics

Helical wire rope isolators conquer shock and vibration to protect shipboard electronics.

By Aeroflex Laboratories, Inc.



Delicate shipboard electronics must survive and operate throughout the entire range of environments that the ship will see, ranging from the heat and humidity of equatorial regions to the cold, snow and ice of the polar regions. Simultaneously, the equipment must cope with the inevitable and constant vibration that accompanies a ship underway. In addition, on fighting ships, it must withstand the shock and vibration conditions that occur during combat. The trend today is to design in helical wire rope isolators to conquer shock and vibration, thus providing life of ship protection for electronic packages.

A case in point: Computing Devices Company, a division of Control Data Corporation in Ottawa, Canada, supplies military electronic equipment to Canadian and American forces. One such piece of equipment is known under the acronym SHINPADS, or Ship Integrated Processing and Display System. Located in the operations center of a combat ship, SHINPADS displays various types of navigational and tactical information.

Cooperating with Aeroflex International of Plainview, NY, Computing Devices Company has designed and developed a vibration isolation system for a particularly sensitive part of the SHINPADS system. In the past, the most widely used tactic against both vibration and shock was simply to make the equipment more rugged mechanically – bigger, stronger, heavier. Ruggedizing equipment has been the traditional approach to coping with naval shock, and an engineering objective was to make equipment so rugged that shock isolation was unnecessary. Today, engineers look at the shock problems a little differently. Shock and vibration isolation systems are becoming better functionally and they are better engineered; they are more predictable and thus, they become a more acceptable part of a system design. Additionally, the use of isolators allows the use of commercial equipment, at considerably lower cost.

SHINPADS Requirement

The operator's console of SHINPADS weighs approximately 520 lb. (236 kg) and consists of an electronics package, a computer-style keyboard, and a cathode ray tube terminal. According to Mr. Douglas R. Watson, Computing Device's mechanical design engineer on

the SHINPADS project, only the upper half of the console is protected with vibration isolators.

Mr. Watson notes, "The most sensitive components of the system are the keyboard and the video display, which weigh about 270 lb. (123 kg) together. This portion is mounted on four helical isolators oriented front to back. Because the center of gravity of the equipment is not located midway between the front and back, two different helical isolators were selected. For the front, we chose a firmer isolator, and for the rear, we use the somewhat softer isolator."

This firmer CB1380 series of isolators use 3/8 inch (9.5 mm) diameter wire rope and the softer CB1280 series use 1/4 inch (6.25 mm) diameter wire rope.

Shock/Vibration Underway

Mechanical shock experienced onboard a ship can tear an electronic cabinet off of its mounting bolts, severing electrical cables. Electronics can be destroyed if not protected from the forces of direct contact explosions, underwater detonations, and the firing of the ship's own weapons and missiles.

Naval designers are responsible for assuring that a fighting ship and its electronic equipment will meet the vibrations and shocks it will see in service. Equipment received from the original manufacturer, and sometimes from other government, agencies, must be verified that it can pass the shock tests that have been established.

While the damaging effects of vibration are well recognized, a significant amount can be designed out to minimize sensitivity to fundamental driving frequencies. Sensitive electronic equipment is effectively protected and isolated by using vibration dampers.

Ship vibration is caused primarily by the propulsion system (except for resonances that may be excited by shocks), and different type ships have different characteristics frequency ranges. Destroyer type ships, for example, experience vibrations in the range from 5 to 15 Hertz, while an aircraft carrier may see 5 to 25 Hertz, and a submarine 5 to 50 Hertz. Vibration onboard ship is not considered much of an operational problem once the sensitive equipment has been identified and properly isolated.

In Action

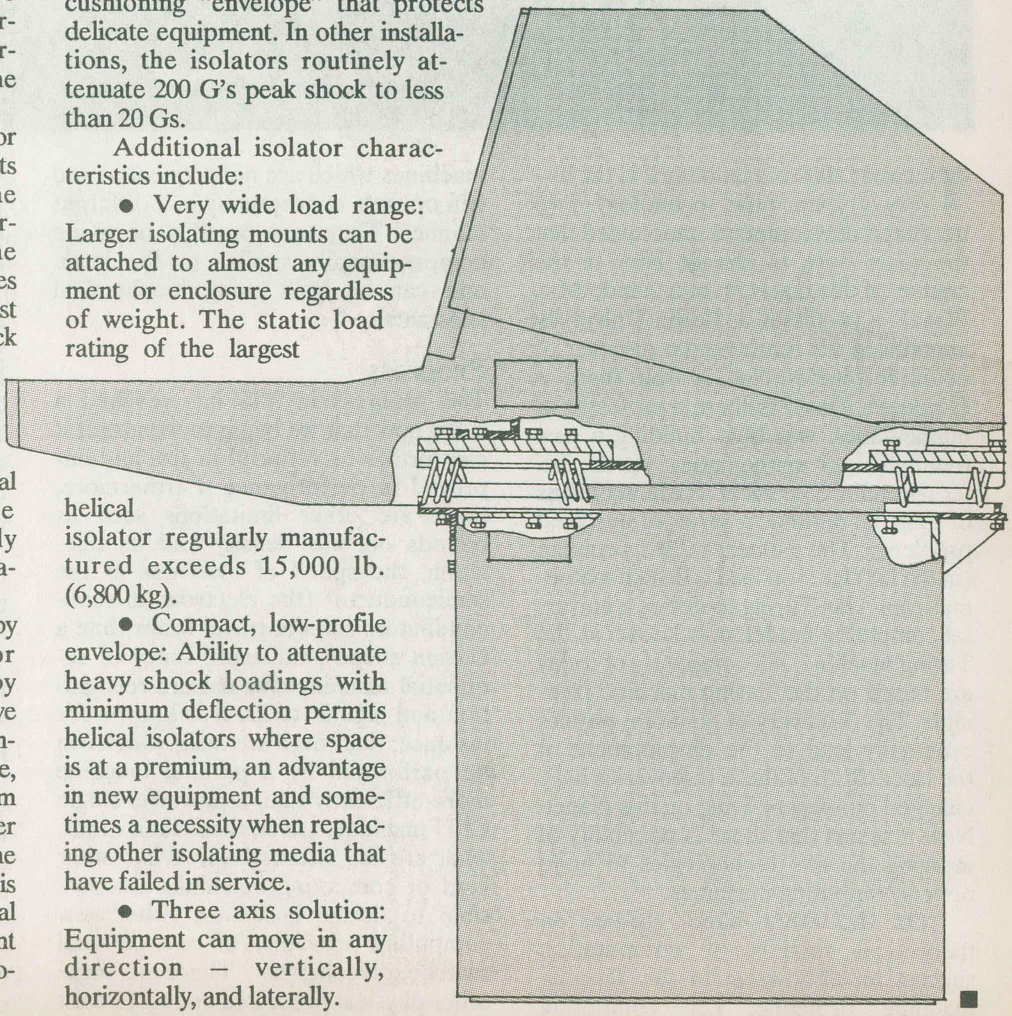
Helical isolators are stable mounting assemblies of high quality standard performed wire rope held between rugged metal retainers. Wound in the form of a helix, each isolating element has specific response characteristics determined by the diameter of the wire rope, the number of strands, the cable length, the cable twist or lay, and the number of cables per section. Inherent damping is provided by flexure hysteresis, i.e., the rubbing and sliding friction between the strands of wire rope.

The unique design of the helical coil isolators can cope with high energy shocks of extremely short duration — 0 to 50 milliseconds — and respond to them over a longer time period — 40 to 80 milliseconds. They also smooth out random and steady state vibrations over a wide range. An unusual feature of isolators is their ability to absorb high energy inputs along the vertical, horizontal, and lateral axes (X, Y, and Z) simultaneously, creating a total-surround cushioning "envelope" that protects delicate equipment. In other installations, the isolators routinely attenuate 200 G's peak shock to less than 20 Gs.

Additional isolator characteristics include:

- Very wide load range: Larger isolating mounts can be attached to almost any equipment or enclosure regardless of weight. The static load rating of the largest helical isolator regularly manufactured exceeds 15,000 lb. (6,800 kg).
- Compact, low-profile envelope: Ability to attenuate heavy shock loadings with minimum deflection permits helical isolators where space is at a premium, an advantage in new equipment and sometimes a necessity when replacing other isolating media that have failed in service.
- Three axis solution: Equipment can move in any direction — vertically, horizontally, and laterally.
- Positioning no problem: The isolators can be loaded in compression, tension, shear, or roll in base mount, center of gravity mount, or inclined off axis mount. They can be located anywhere in an isolating system. In the compression/roll attitude, the available stroke of the isolator can exceed its height.
- Excellent environmental resistance: the isolators are made of stainless steel and aluminum alloys. Their performance is unaffected by temperature. They function from -400 to 700 F (-240 to 370 C) and resist ozone, oil, grease, sand, salt spray, and organic solvents. Resistance to environmental attack means that helical isolators require no maintenance and usually will outlast the equipment they isolate. They can be painted to match the equipment.

For additional information on vibration isolators, contact Aeroflex Laboratories Incorporated, 35 South Service Road, Plainview, NY 11803, (516) 694-6700.



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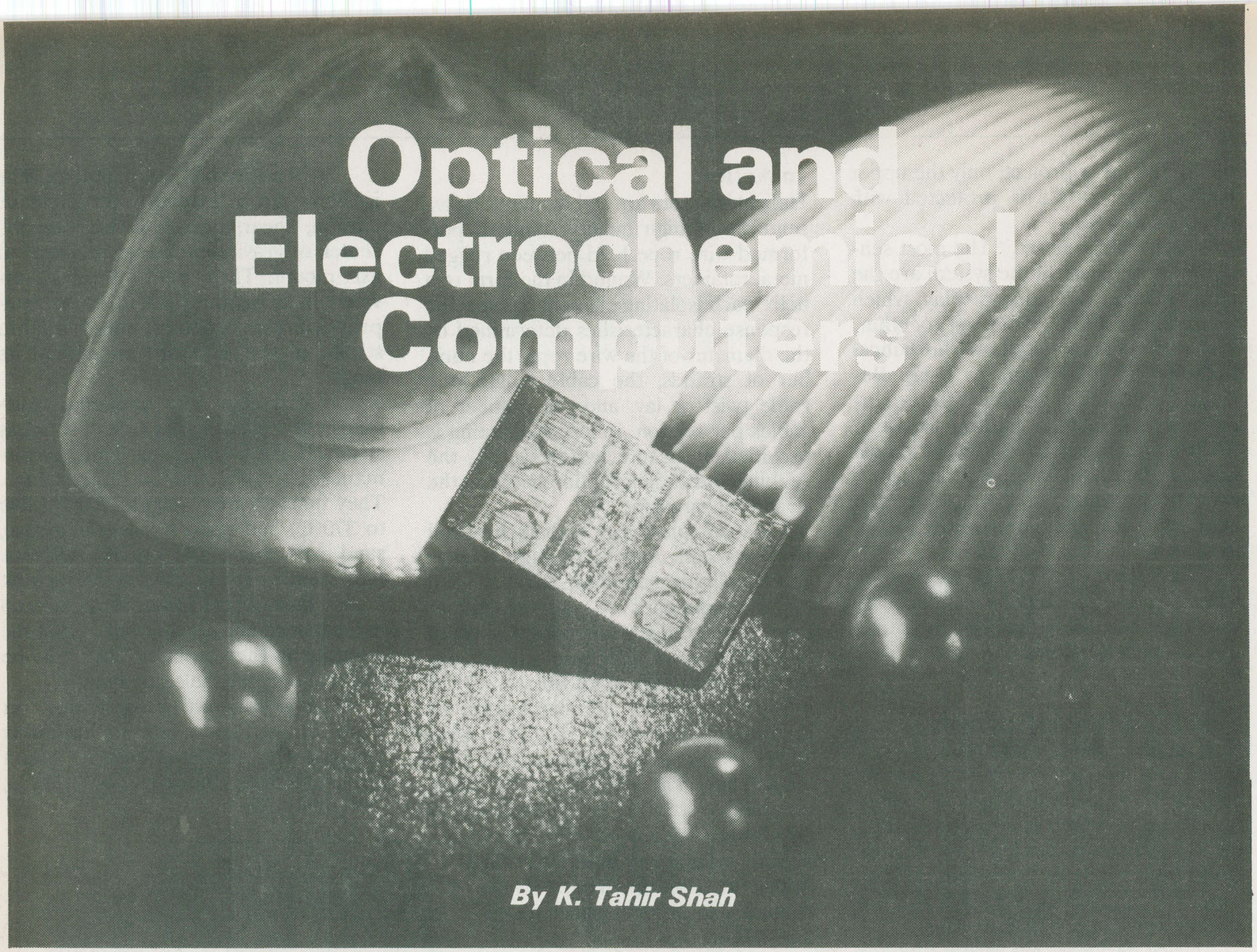
Optical and Electrochemical Computers



By K. Tahir Shah

The year 1900 is a landmark in the history of science and technology. Two unrelated developments announced that the years were to change later in the course of history. On one hand, Max Planck, a professor at Berlin University announced his fundamental discover of quantum physics. Not far from there at Gottingen, David Hilbert, a professor of mathematics, was busy building a new foundation of mathematics. At the International Congress of Mathematicians of 1900, he outlined a series of unsolved problems. The Hilbert's 23rd problem (in the list) later on lead a British mathematician Alan Turing to device a universal computing model, now known as the Turing machine. All computers of today are based on the Turing machine principle. The discovery of quantum physics eventually lead to the development of the laser. Both of these discoveries have changed our way of living on this planet. Now it seems that there is possibility of merging the two technologies to build optical computing machines.

On the other hand, studies on theoretical models of computation suggest an alternative to the Turning machine principle, i.e., computing machines which are not sequential and can operate conceptually in a different manner. They may possibly be made computationally similar to the brain and can be built using biochemical substances.

Progress

The progress in VIS has reached a stage now that we begin to wonder if it can further be reduced in size and improved in performance. Furthermore, there are other limitations such as bounds on VIS density and its linewidth, the speed of electrons in the semiconductor (the electrons in semiconductors can not travel faster than a certain speed), the inefficiency of sequential machines for pattern recognition and similar tasks. It is known, for instance, that there are tasks which can be performed by a parallel machine more efficiently than a powerful single CPU machine. Given these limitations, what are the alternatives? What other kind of computing machines are possible to design based on either new computing principles or new physical switching mechanism? There are some other physical processes known to exist which can be used for information processing, such as the use of coherent light (laser) instead of electrons (electrical current) or chemicals.

In 1969, Abraham Smoke from the Massachusetts Institute of Technology predicted the existence of an optical bristle device which was observed in 1976 by N.C. Venkatesan et al., of Bell Laboratories. Since then researchers continue to look for materials which can eventually be utilized to build an optical computer.

Some five years ago I read that a commercial organization was planning to design and build a functional molecular electronics computing device. The news was quite exciting to me at the moment because only a year earlier I was involved in research on the computational aspect of self-organized systems. According to officials of the same company, such a device was considered feasible and a prototype was expected to be complete within five years. Although there have been no serious developments in electrochemical computing since then, some later studies suggested that it may be possible to develop chemical computers eventually. Certainly, it is

something which we will not see in the next few years.

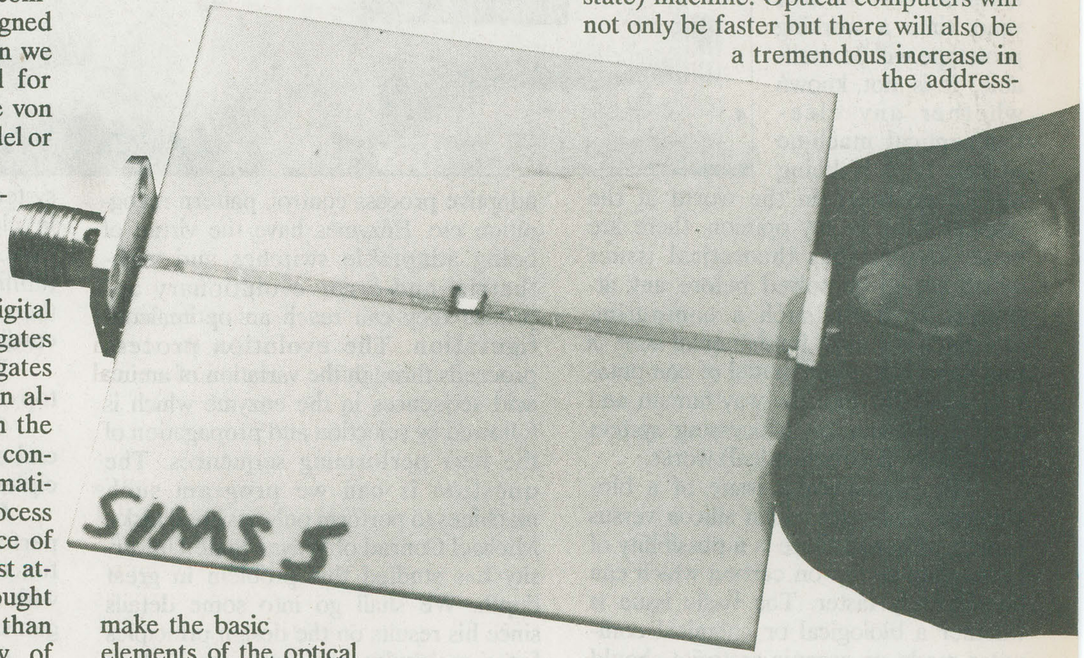
Development

The development of computing machines started with the search for a theoretical computation model applicable universally to all machines which are to be the (physical) embodiment of such model. These machines approximate their operational behavior as closely as possible to the one suggested by the computation model. As mentioned above all digital electronic computers are moldered on an ideal machine called Turning machine (named after Alan Turning). From the operational point of view it is strictly a sequential machine, i.e., it does only one thing at a time whether it be reading or writing. A further generalization of this machine by John von Neumann (to include memory) played the fundamental role in the development of digital computers. In fact, von Neumann designed and built the first computer. When we refer to the computation model for electronic computers we mean the von Neumann-Turing computation model or briefly Turning machine.

On the physical side, all computing machines depend on some kind of switching mechanism at their fundamental operational level. In today's digital electronics this is achieved by the gates consisting of transistors. These gates represent Boolean operation of an algebra invented by George Boo in the nineteen century. His work is also considered as foundational in mathematical logic, the human thought process and what is now called the science of artificial intelligence. It was the first attempt to formalize human thought process. At the level lower than Boolean gates, in an hierarchy of processes, transistors (electronic tubes in the early days of computing) or similar devices are used to control the flow of current. In an on-and-off device, the current is either passed through this device or not at all. this is achieved by using a controlled threshold mechanism. In principle, it is not necessary to use electrical current. Something else like, light can also be used to achieve switching operation.

There are other known alternatives to the electronic switching which are subject of current active research. These are laser based optical gates and the biochemical gates. Using lasers instead of electrical current does not require any change in the computation model for optical computers, i.e., they will be Turing machines and all programming theories will remain valid as they are for electronic computers. However, this is not the case with bio-chemical computers. The biochemical computation model falls outside this because of the adaptive nature of enzymes which are to be used as the basic switches. These two new and promising technologies are in the process of emergence. the optical computer technology is ahead of the bio-chip because no theoretical studies are involved. In the long run perhaps both will be competing technologies along with the digital electronics.

Many years ago researchers at the Heriot-Watt University (UK) have demonstrated experimentally how to make the basic elements of the optical data processing machine. S. Desmond Smith and his collaborators constructed a logical gate consisting of a variable intensity laser beam and a crystalline material having nonlinear refractive index. They called the new optical switch a "transphasor", which is an entity equivalent to the transistor in electronics. Because the speed of light is much greater than those of the electrons in a semiconductor material, the typical switching time of an optical device is of the order of picoseconds as compared to electronic switching time of nanoseconds, i.e., the optical switches are about a thousand times faster. One expects, therefore, an optical computer to be about 1000 times faster than the fastest electronic computer.



Switching Principle

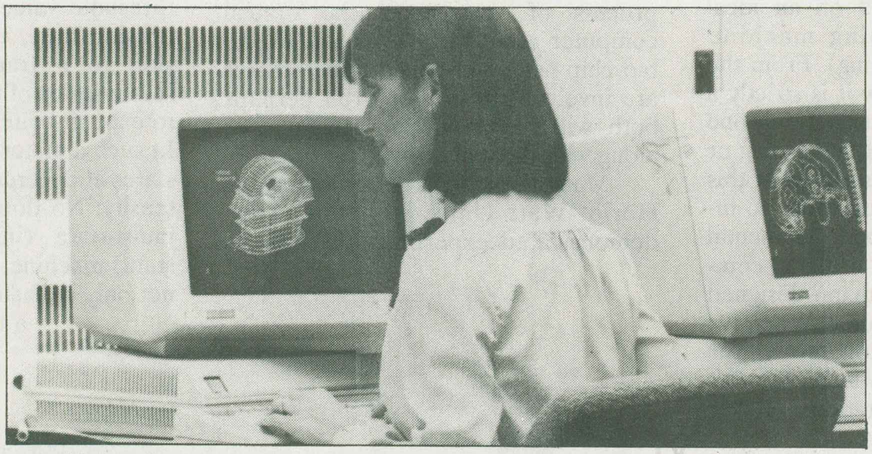
The switching principle is based on the existence of a nonlinear refractive index of certain materials. Any variation in the intensity of a laser beam results in changes in the index of refraction. If the laser beam is shone on a crystal at an appropriate angle, then a small variation in its intensity (near the threshold value) can switch the transmission state, i.e., from a no-transmission to a transmission state. Many stable states of transmission are known to exist in materials such as diamonds. In such a material there are many "on" states at different values of the laser intensity. No doubt this could lead to a multi-state (instead of only binary state) machine. Optical computers will not only be faster but there will also be a tremendous increase in the addressing space for the same bus lines. A transphasor is not only a binary but an N-ary stable device where N can be greater than two. Moreover, many frequencies of a laser can operate simultaneously on the same crystal without interfering with each other. this is certainly not possible in electronics.

Earlier I mentioned a commercial bio-chemical computer project. Their plan was to build a molecular electronic switch array with special proteins called "oriented antigen monolayers" (OAM), "monoclonal antibody" (MA), and "pep

tide interface" (PI) as their basic ingredients. The final completed structure, called a Moleton, is like an electronic active element, i.e., a transistor or semiconductor impurity junction. An enzyme reacts with chemicals floating in the biological soup to produce the final component of the computer system, including a lead compound which is to act as the entry or exit point of any information addressed to the computer. In this type of computer the information is not stored in binary form but in ternary form, with on, off, and not defined states. Since a full technical report is not available, it is not clear to me how three stable states are possible.

Although such a configuration was proposed by a US company in 1982 and claimed that in five years time a working prototype will be available, it is not known whether any electrochemical machine of this type is being tested anywhere in the world at the present time. In my opinion, there are some very serious theoretical issues which are to be solved before any attempts to build such a computing machine. The most fundamental issue is that there is no such model of computation which fits into the way human and animal information processing system (essentially electrochemical) works.

The fundamental issue of a biochemical computer is not silicon versus carbon, although there is a possibility of developing a chip on carbon which can be relatively faster. The basic issue is whether a biological or chemical computer made or organic material should be or should not be of von Neumann-Turing type, i.e., should they be like electronic digital computers or not. There are many reasons why a chemical computer should be based on a computational model other than the Turing machine. For example, all communication in the endocrine and the nervous system utilizes lock-and-key mechanism. In both of these systems, chemical messengers (hormones and neurotransmitters) are released from one cell, travel through the extracellular medium and then bind to receptors on the surface of the receiving cell to modify its activity. If the chemical messenger does not fit properly at the receptor end, it is unable to come close enough to trigger any activity by the receiving cell. The shape based specificity is a form of tactile pattern recognition. A similar task, if performed by an electronic digital machine, would require an enormous number of switching processes. Although protein enzymes are much slower switches thank transistors, (typically 0.1 millisecond as compared to nanosecond) they are better suited for tasks where sequential processing is not the answer, such as



adaptive process control, pattern recognition etc. Enzymes have the virtue of being adaptable switches and withthetrial-and-error evolutionary approach they can reach an optimalconfiguration. The evolution process proceeds through the variation of amino acid sequences in the enzyme which is followed by selection and propagation of the best performing sequences. The question is can we program such machines to perform only assigned tasks. Michael Conrad of Wayne State University has studied this problem in great depth. We shall go into some details since his results on the design principles for a molecular computer are of fundamental importance. His main result is what he called a tradeoff principle.

Conrad's Tradeoff Principle

A system can not at the same time be effectively programmable, amenable to evolution by variation and selection, and computationally efficient.

Let me explain. In computation theory there is a thesis known as the Church-Turing thesis which states that any effectively computable function is computable by a formal process involving simple operation on strings of symbols. A computer program is a rule that generates such a process. For a von Neumann-Turing computer such programming languages do exist and are defined by a finite, discrete base set of symbolic primitives. It is always possible to write a program in a language that directly maps the structure of the machine and the state of each component. this is called structural programmability and is the basis of all other forms of programmability.

The Conrad's Tradeoff principle suggests that an alternative domain of computing is possible (in principle) where programmability is exchanged for efficiency and adaptability. Biological systems, as the product of evolution must operate in this alternative domain.

Enzyme-driven computing in biological systems depends on complex and intricate process of self-organization and self-maintenance. Creating such a self-organized system with a support and repair system in clearly not feasible at the present time. to exploit the efficiency-adaptability side of the tradeoff relation, there are at least four approaches according to Michael Conrad:

Building a virtual machine on the top of a von Neumann-Turing machine.

Constructing electronic devices to embody the desired dynamical principles to the greatest extent possible.

Culturing existing organisms to perform useful information processing function. This may come into conflict with the evolutionary goals of the organism itself.

Construction of enzyme driven simple devices for the task where the lifetime of the device is not a major concern.

Whether or not it is possible to develop chemical computers depends on the fact that thee is an urgent need to do so, plus available science and technology. There are some applications where biocomputers can be far more efficient than the digital electronic computers. Initially there is some potential for simple bio-chemical sensors which could be used as testing ground for further development eventually leading to chemical computers. ■

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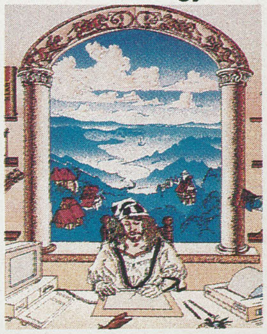

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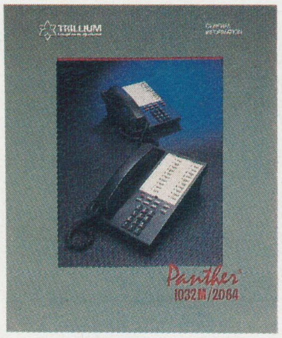
Panther Phones



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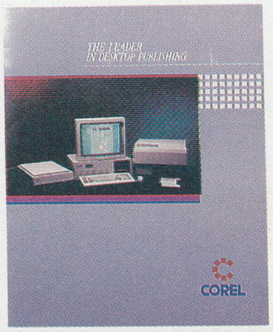

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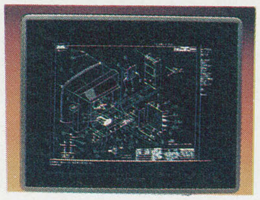
Sak Data Products Ltd. has introduced the CD 1920 color monitor from Moniterm Corporation. This 19.6 inch color monitor displays flicker-free ultra sharp images on a raster of 1280 x 1024 pixels. RGB inputs and a horizontal scan rate range of 14 to 72 KHz make the CD 1920 compatible with all of the popular video graphics controllers including Moniterm's own Viking 10 and Viking 20 controller cards. An efficient design means that the CD 1920's takes up less than two-thirds the space than that of comparable monitors, and the unit also features a convenient tilt and swivel base.



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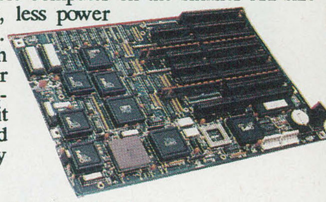
Microframe 386

Sak Data Products Ltd. has introduced the Microframe 386 from Monolithic Systems Corp. The Microframe 386 provides high performance 80386 processing power, at 16 MHz or 20 MHz operation, and AT compatibility. Using VLSI technology, the Microframe 386 is able to implement this powerful full 32-bit AT compatible computer on the smaller XT-size motherboard resulting in fewer parts, less power consumption and greater reliability. Mounting holes are provided for both XT and AT chassis standards. Other features include a socket for an optional 80387 math co-processor, full 32-bit zero wait state memory, six AT and two XT expansion slots and capac-ity for up to 8 MB of on-board RAM.



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Viking For the Mac

Sak Data Products Ltd. has introduced the long awaited Viking series of 19'' monitors for the Apple Macintosh computer. Based on Moniterm's best-selling PC compatible Viking 1, the Viking SE and Viking II allow users of the Macintosh SE and Macintosh II respectively to experience the crisp flicker- free display familiar to Viking 1 users. The paper-white, 1280 x 960 screen displays two full pages with detailed readable characters formed from square pixels. The powerful controller installs into the Macintosh and avoids processor wait states that slow down screen updating. The Viking Video System series features an interchangeability of the display monitor between the Mac SE/II, IBM PC/XT/AT and PS/2 controllers; all of which are available separately.

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Moniterm Viking Graphic Display Systems

Sak Data Products Ltd. has introduced the Viking PRT Graphic Display System from Moniterm Corp. The Viking PRT features a 19-inch portrait mode monitor and a high-speed graphics controller designed for the IBM PC/XT/At and PS/2 Model 30 based workstations. Crystal clear, flicker-free images are displayed on the paper white phosphor with square pixels. Using a raster of 900 x 1280 pixels, the Viking PRT is the first publishing-resolution display system for desktop publishing of tabloids, broadsheets and other publications. Bundled GEM and Windows drivers allow the Viking PRT user to display true WYSIWYG documents created with Aldus PC PageMaker, Xerox's Ventura Publisher and other DTP software.

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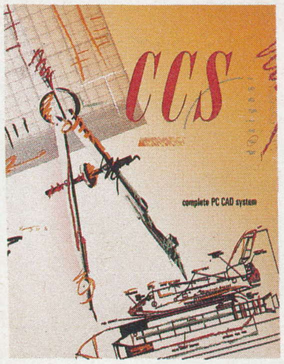

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Commodore Products

Commodore Business Machines Limited is a leading Canadian manufacturer of a wide range of personal computers for home, school and business applications. Commodore's line includes the powerful Amiga 2000, Amiga 500, and 64C computers. Their line of IBM XT compatible computers, including the PC 20-III, gives Commodore a competitive machine for the popular MS-DOS market. As well, Commodore supplies a broad selection of peripheral devices.

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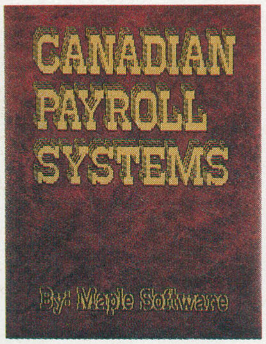

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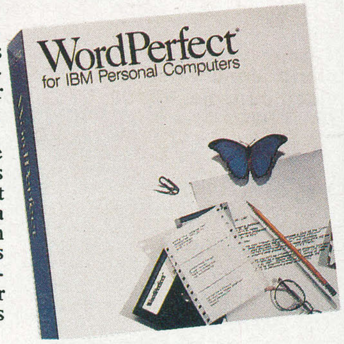

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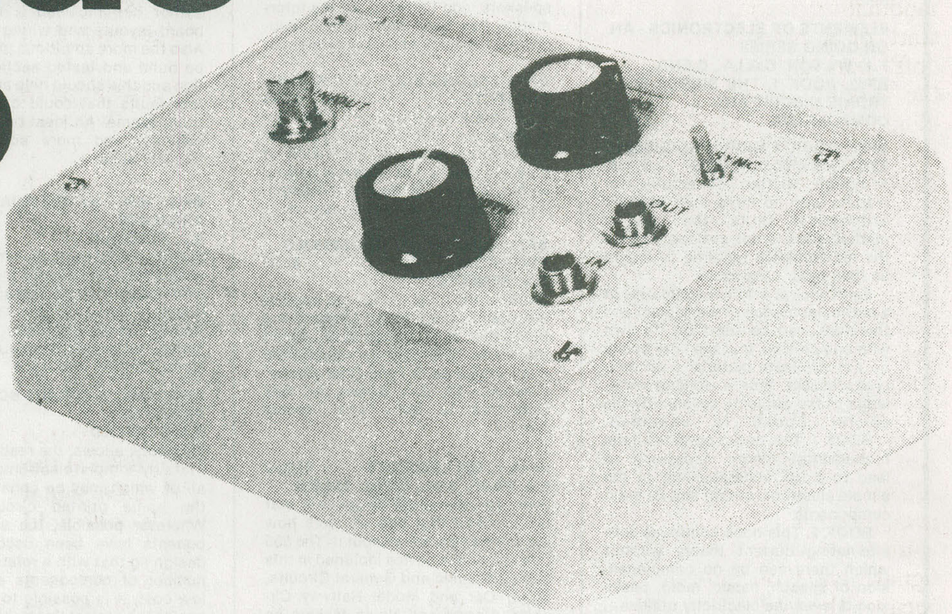
Pseudo Echo Unit



Produce realistic echo effects at a realistic price.

By Robert Penfold

This device is really a form of tremolo unit, but when used with an instrument (such as a guitar) which has a fast attack and slow decay, it provides an effect which is much more like an echo effect than a conventional tremolo type. The unit differs from a standard tremolo rather than the more usual sinewave or triangular signal.

The effect of a normal tremolo unit is much the same as manually varying the volume up and down at a rate of (typically) a couple of times per second, and this effect can be generated manually via a swell pedal. The effect of this unit is to switch the signal on and off with no in-between state. This can be used as a rather harsh and extreme form of tremolo, but it is probably most effective when used on a suitable signal to give a pseudo echo effect.

The waveform of **Fig. 1** shows how this effect is obtained. The input signal must be a type having a fast attack with a much slower decay time if the right effect is to be produced. The output from an electric guitar is in this category, and synthesizers and most other electronic instruments can provide a suitable signal.

The effect of the unit is to chop up the signal into short bursts, and the output from the unit is therefore a series of signal bursts that start at a high level and gradually decay. The sound this gives is very much the same as if a short burst of signal were to be fed into an echo effects unit.

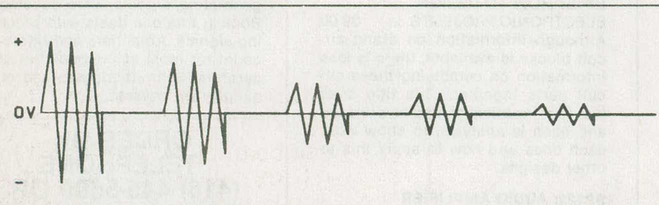


Fig. 1. (above). A combination of the signal's natural decay and the chopping effect of the unit gives an echo effect.

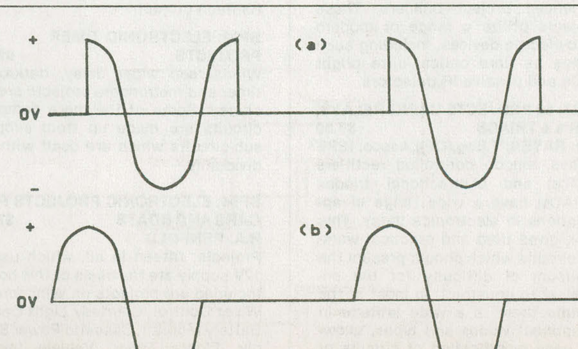


Fig. 2. (right). The waveform of (a) is the result of a simple chopping process; (b) is the result of incorporating zero switching in the process.

There are limitations to this way of doing things, and the main one is that it only works properly with a signal that has a suitable envelope shape, and which remains essentially the same throughout its duration. With most instruments there is no problem in either case, but the obvious exception is a voice signal which is unsuitable in both cases.

Another problem, and one which is most troublesome when using a low modulation frequency, is that of the start of a note occurring during an "off" period. This can seriously effect the timing of the music, and by eliminating the important attack period of the signal it can drastically alter its sound.

The Pseudo Echo Unit described here has a simple synchronization facility which can be switched in when using low modulation frequencies, so that the unit is forced to commence an "on" phase at the start of each new note. This seems to totally eliminate the "of" period problem.

Zero Switching

A third problem with this very harsh form of amplitude modulation is that it tends to produce "click" sounds as the signal is gated on and off. This happens because the unit will usually switch the signal on or off when it is not at zero volts. This gives a sudden change from whatever level the signals happens to have at instant of switching, to the zero volts level. Under worse case conditions a waveform of the type shown in **Fig. 2a** is obtained, where the signal switches from its peak level to zero volts of each transition of the signal gate.

There are ways of reducing or eliminating the problem, and in this circuit zero point switching is used. This is very effective indeed and it permits quite high switching frequencies to be used without any significant switching glitches being generated at all.

The method used is very simple in essence, and it avoids the switching glitches by synchronizing the modulation signal with the input signal in such a way that the signal gate only switches state as the input signal passes through 0V. This gives an output signal of the type shown in **Fig 2b**, with only sets of complete half cycles present.

System Operation

The block diagram of **Fig. 3** shows the general arrangement used in Pseudo Echo Unit. A buffer stage is used at the input of the unit, and the main signal path is through the sample and hold circuit to the output socket.

The sample and hold circuit is a form of signal gate, and it allows the input signal to pass straight through to the output when it is supplied with a "high" control signal. Switching the control input "low" blocks the signal

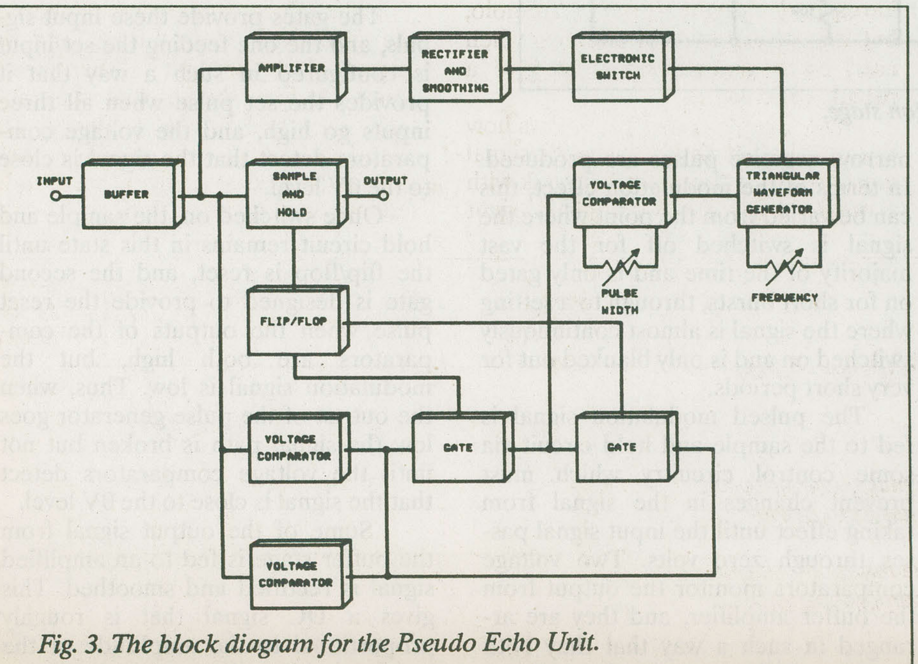


Fig. 3. The block diagram for the Pseudo Echo Unit.

PARTS LIST

Resistors

- R1 R2, R15.................. 100k
- R3, R10, R16, R17, R18, R22
- R23.................................. 10k
- R4, R5, R11, R12 .... 4k7
- R6, R9............................ 1M
- R7, R8, R21 .... 2k2
- R13................................ 220k
- R14.................................. 47k
- R19, R20......................... 15k
- All 1/4 W 5% carbon

Potentiometer

- VR1............................ 47k lin
- VR2............................. 1M lin
- VR3 100k sub-min hor. preset

Capacitors

- C1, C5 100u radial elect. 10V
- C2, C6 .... 470n polyester
- C3 .... 10n polyester
- C4 ....10u radial elect. 25V
- C7, C9 ....2u2 radial elect.
- C8...........1u radial elect. 63V

Semiconductors

- D1 to D8.................... IN4148 silicon signal diode
- TR1 .... 2N5818 npn silicon
- IC1 LF351....... bifet op amp
- IC2 .... 4016BE CMOS analogue switch
- IC3 CA3140E MOS op amp
- IC4 .... 4001BE CMOS quad 2-input NOR gate
- IC5,7 ....1458 dual op amp
- IC6,8 .... 741C op amp

Miscellaneous

- SK1................ Standard jack with DPDT switch contacts
- SK2 ..... Standard jack socket
- S1 locking pushbutton switch
- S2 .... Part of SK1
- S3 .... Miniature SPST toggle switch

Case, sloping front type about 165 x 70 x 125mm; printed circuit board; two controls knobs; B1, 9V; six 1.5V size cells in plastic holder; battery connector (9V type); 8-pin DIP socket (6); 14-pin DIP sockets (2); pins, wire, solder, etc.

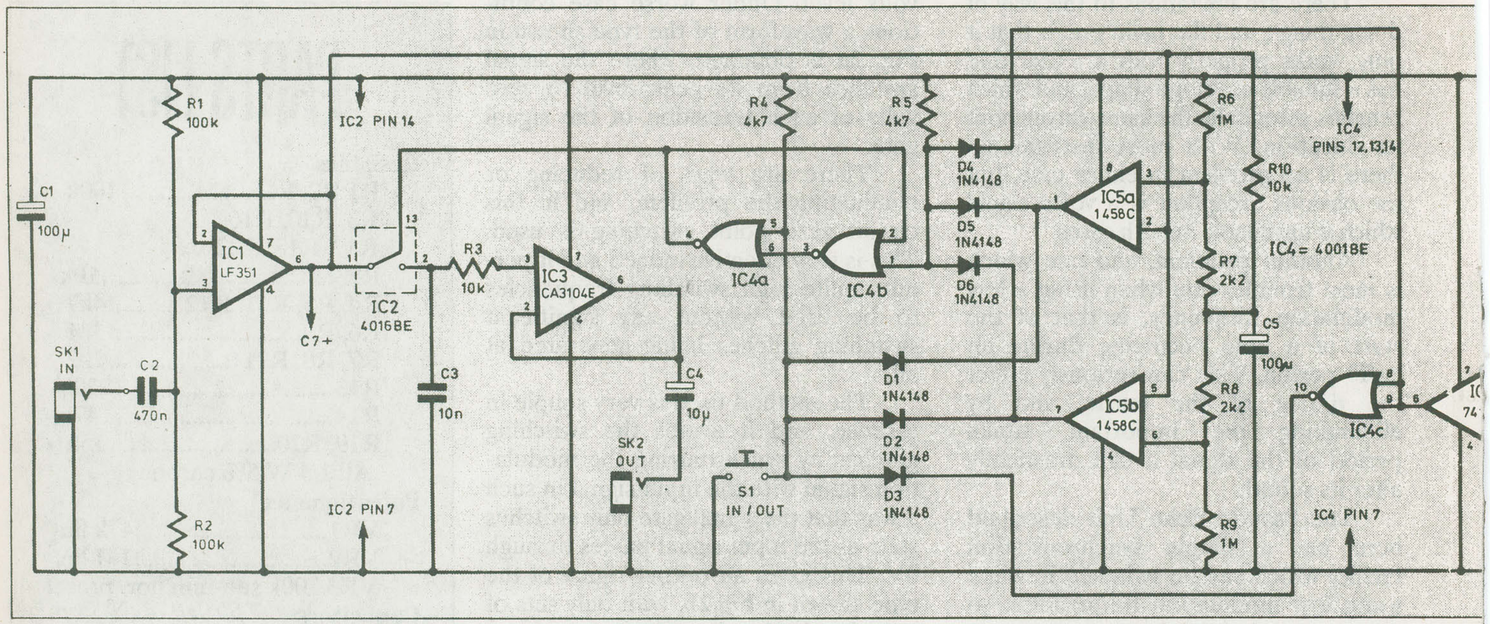


Fig. 4. The main circuit diagram for the Pseudo Echo Unit.

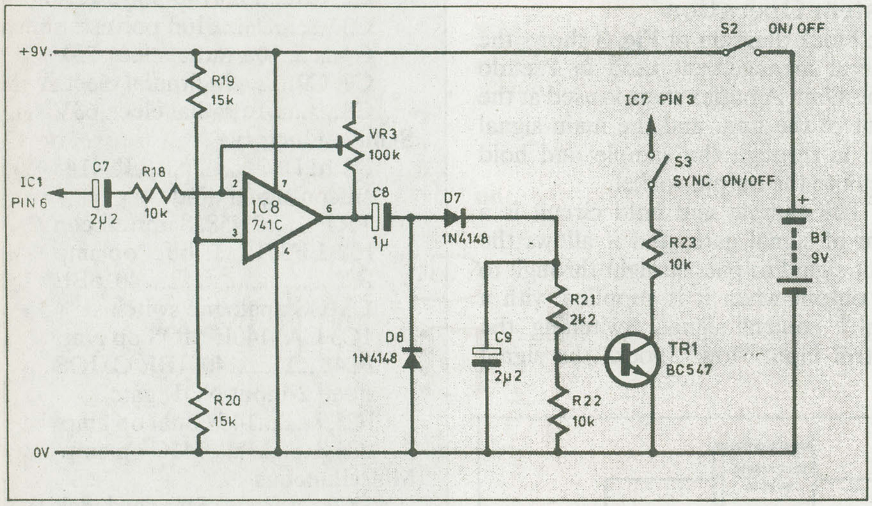


Fig. 5. Circuit diagram for the synchronization stage.

path, and the output is maintained at whatever level it happened to have at the instant when the signal was cut off. It is important that the output is not simply allowed to drift as this could result in unwanted "clicks" and other noises on the output signal.

The modulation signal is generated by a triangular waveform generator which feeds into a voltage comparator. The other input of the comparator is fed from a variable reference voltage, and this combination constitutes a conventional variable pulse generator.

The output signal can be continuously varied from narrow positive "needle" pulses through a 1 to 1 squarewave and on to the point where narrow negative pulses are produced. In terms of the modulation effect, this can be varied from the point where the signal is switched off for the vast majority of the time and is only gated on for short bursts, through to a setting where the signal is almost continuously switched on and is only blanked out for very short periods.

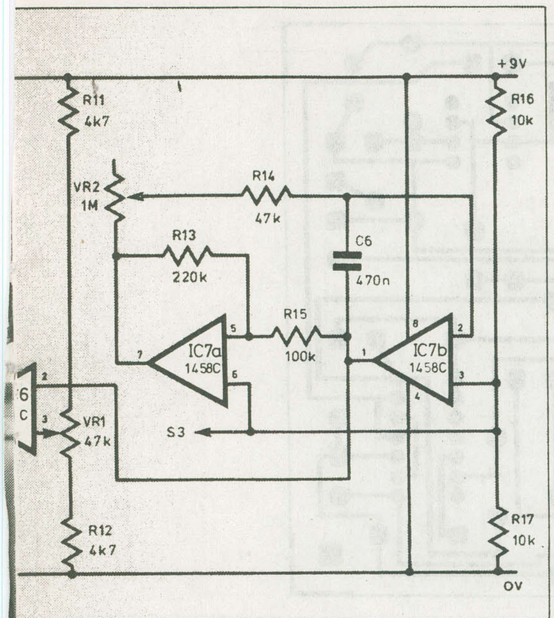
The pulsed modulation signal is fed to the sample and hold circuit via some control circuitry which must prevent changes in the signal from taking effect until the input signal passes through zero volts. Two voltage comparators monitor the output from the buffer amplifier, and they are arranged in such a way that they both provide a high output level only when the signal is very close to the 0V level. The voltage comparator outputs, together with the modulation signal, are fed to the inputs of two logic gate circuits.

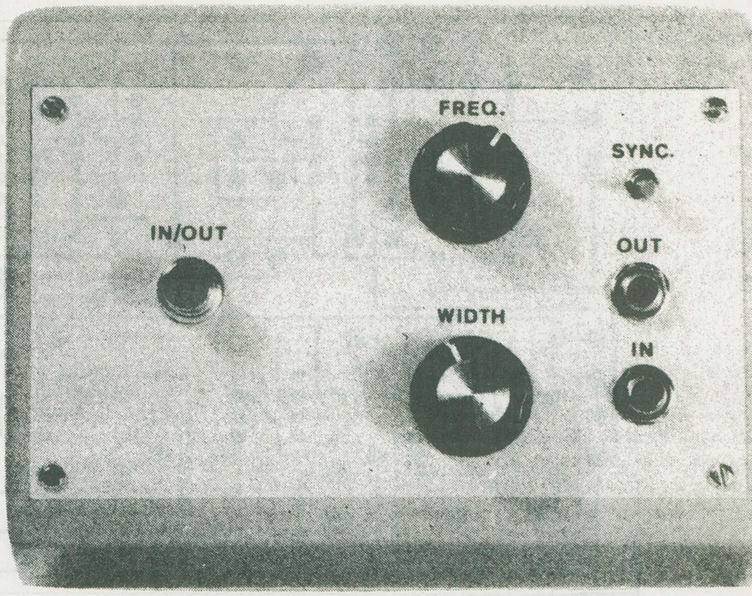
A simple S/R (set/reset) flip/flop provides the control signal for the sample and hold circuit. The flip/flop must be supplied with a high input signal to its "set" input in order to switch on the sample and hold circuit, and a high input level is then needed at the "reset" input in order to take the sample and hold circuit back to the "hold" mode.

The gates provide these input signals, and the one feeding the set input is configured in such a way that it provides the set pulse when all three inputs go high, and the voltage comparators detect that the signal is close to the 0V level.

Once switched on, the sample and hold circuit remains in this state until the flip/flop is reset, and the second gate is designed to provide the reset pulse when the outputs of the comparators are both high, but the modulation signal is low. Thus, when the output of the pulse generator goes low the signal path is broken but not until the voltage comparators detect that the signal is close to the 0V level.

Some of the output signal from the buffer stage is fed to an amplified signal is rectified and smoothed. This gives a DC signal that is roughly proportional to the amplitude of the input signal. For the synchronization to





The finished echo unit, showing the footswitch mounted on the far left of the front panel.

work properly the input signal must be a type which has a fast attack time with a reasonably rapid initial decay characteristic. Guitars and signals with form, and the electronic switch is turned on briefly each time a note is played. The switch is connected to the biasing circuit of the triangular waveform generator, and it is has the effect of forcing the start of a new cycle each time the switch is closed, thus giving the required synchronization effect.

Circuit Operation

The main circuit diagram for the Pseudo Echo Unit appears in **Fig. 4**, but the synchronization circuit is shown separately in **Fig. 5**.

The buffer amplifier (IC3) at the output ensures that there is no significant discharging of capacitor C3 during the "hold" periods. The CA3140E specified for the IC3 posi-

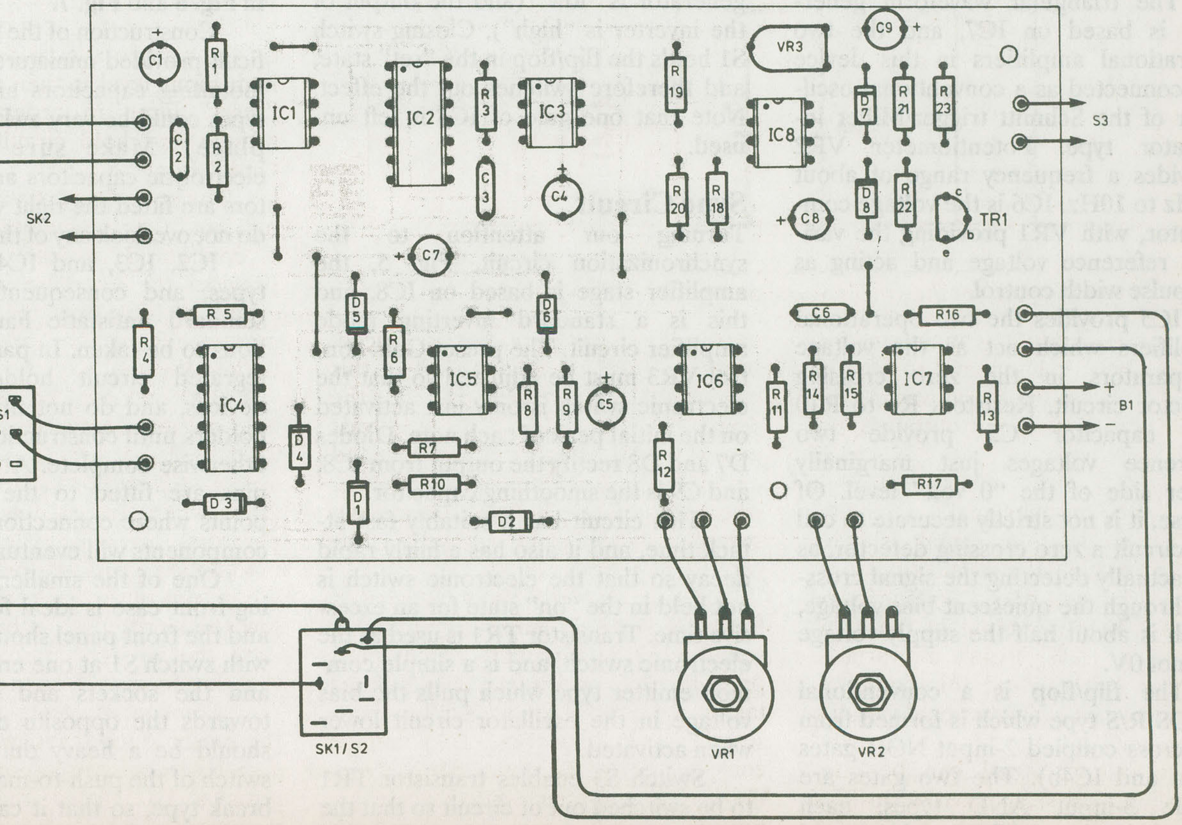


Fig. 6. The printed circuit board component layout and interwiring details for the case-mounted components.

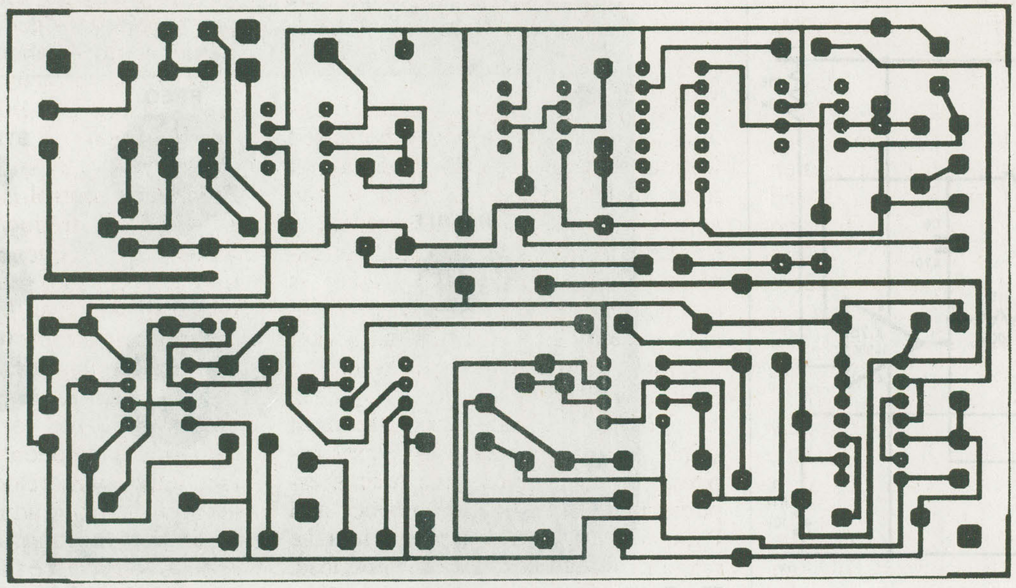


Fig. 7. Full size printed circuit board foil pattern.

tion is a MOS input type which gives an input impedance of over one million megohms. Note that there are actually four switches in IC2, but in this circuit only one is used and there are no connections to the other three.

The triangular waveform generator is based on IC7, and the two operational amplifiers in this device are connected as a conventional oscillator of the Schmitt trigger/Miller integrator type. Potentiometer VR2 provides a frequency range of about 0.5Hz to 10Hz. IC6 is the voltage comparator, with VR1 providing the variable reference voltage and acting as the pulse width control.

IC5 provides the two operational amplifiers which act as the voltage comparators in the zero crossing detector circuit. Resistors R6 to R10 and capacitor C5 provide two reference voltages just marginally either side of the "0 volt" level. Of course, it is not strictly accurate to call this circuit a zero crossing detector, as it is actually detecting the signal crossing through the quiescent bias voltage, which is about half the supply voltage and not 0V.

The flip/flop is a conventional CMOS R/S type which is formed from two cross coupled 2-input NOR gates (IC4a and IC4b). The two gates are simple 3-input AND types, each formed from a pullup resistor and three diodes. However, the one which drives the reset input of the flip/flop is driven from the pulse generator by way of IC4c which is connected to operate as an inverter. This gives the desired action with the reset pulse being produced when the output of the pulse generator is "low" (and the output of the inverter is "high"). Closing switch S1 holds the flip/flop in the "set" state, and therefore switches out the effect. Note that one gate of IC4 is left unused.

Sync Circuit

Turning our attention to the synchronization circuit, Fig. 5, the amplifier stage is based on IC8, and this is a standard inverting mode amplifier circuit. The preset Gain control VR3 must be adjusted so that the electronic switch is only just activated on the initial peak of each note. Diodes D7 and D8 rectify the output from IC8, and C9 is the smoothing capacitor.

This circuit has a suitably fast attack time, and it also has a fairly rapid decay so that the electronic switch is not held in the "on" state for an excessive time. Transistor TR1 is used as the electronic switch, and is a simple common emitter type which pulls the bias voltage in the oscillator circuit lower when activated.

Switch S3 enables transistor TR1 to be switched out of circuit so that the synchronization can be disabled (which can be beneficial when using high modulation frequencies).

Construction

The component layout and full size printed circuit board foil master pattern for the Pseudo Echo Unit is shown in **Fig. 6** and **Fig. 7.**

Construction of the board is not difficult provided miniature printed circuit mounting capacitors are used (larger types could be very awkward to fit into place). Make sure that all the electrolytic capacitors and semiconductors are fitted the right way around and do not overlook any of the six link wires.

IC2, IC3, and IC4 are all MOS types, and consequently require the standard antistatic handling precautions to be taken. In particular, use integrated circuit holders for these devices, and do not fit them into the holders until construction of the unit is otherwise complete. At this stage only pins are fitted to the board at the points where connections to off-board components will eventually be made.

One of the smaller types of sloping-front case is ideal for this project, and the front panel should be arranged with switch S1 at one end of the panel, and the sockets and other controls towards the opposite end. Switch S1 should be a heavy duty push button switch of the push-to-make – push-to-break type, so that it can be operated by foot. It is for this reason that it should be mounted well clear of the

other front panel mounted components (so that they do not impede operation of this "foot switch").

The completed printed circuit board is mounted on the base panel of the case using the normal mounting pillars or screws plus spacers. It is then wired up to the front panel mounted components, see Fig. 6, and there is no need for any of this wiring to be screened, but it should be kept reasonably short and direct. In Fig. 6 it has been assumed that on/off switch S2 will be a set of make contacts on the input socket SK1. A socket with a single set of make contacts is unlikely to be obtainable, and it is therefore necessary to use two contacts of a socket having DPDT types.

With this method of switching the unit is automatically switched on when a plug is inserted into SK1, and switched off again when the plug is removed. This is common practice with musical effects units, but obviously an ordinary socket and a separate on/off switch can be fitted if preferred.

In Use

If the synchronization feature is ignored initially, the unit can be tested without setting up VR3. The output from socket SK2 is coupled to the amplifier, mixer, or whatever via a standard screened jack lead. As explained previously, the unit is automatically switched on when a signal source is connected to input-socket SK1, and switched off again when the plug is removed.

The effect is not one of the most subtle ones and it should be very apparent on any input signal. A little experimentation with the Frequency and Pulse Width controls will soon reveal the range of sounds that can be produced. The unit will work satisfactorily with a wide range of input levels, but it is not suitable for use with very low level sources such as microphones and some guitar pickups unless a suitable preamplifier is added ahead of the unit. Inputs of up to about 6 volts peak to peak can be accommodated before clipping and serious distortion occurs.

It is really only worthwhile using the synchronization facility when the Frequency control is set for quite low modulation frequencies. At high modulation frequencies it is likely to have no noticeable effect, and could be counterproductive by elongating the initial modulation cycle (although you may prefer things this way).

In order to give the preset gain control VR3 the correct setting, start with this component fully backed off (set fully counterclockwise) and then advance it very gradually while playing notes into the unit. Adjust it just far enough to produce the synchronization effect. Remember, the synchronization will only work on signals that have an envelope with an initial transient to switch on transistor TR1.■

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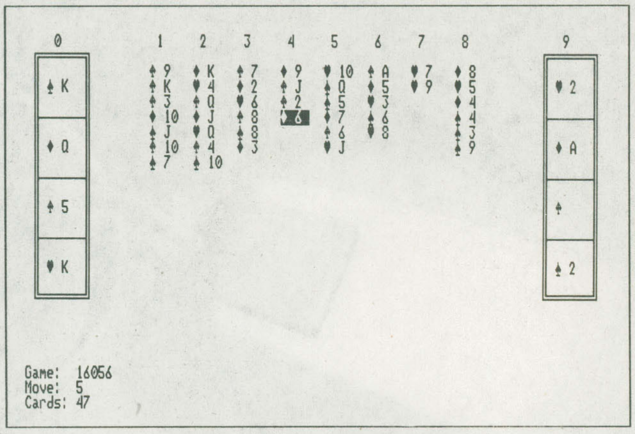

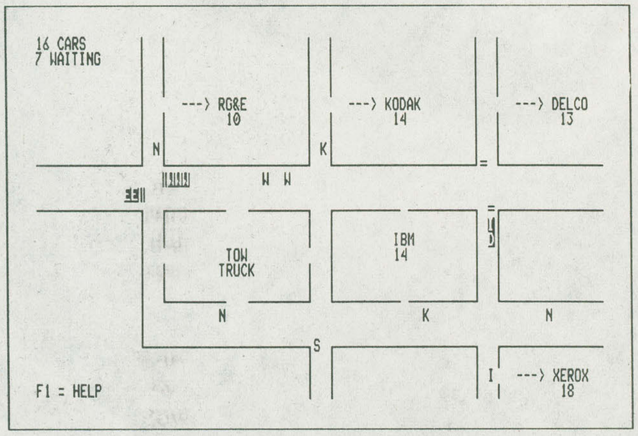

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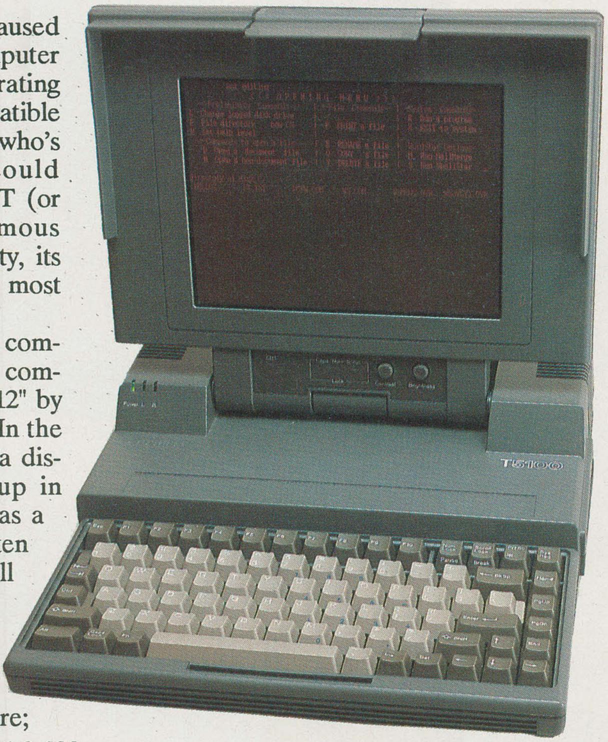
A powerful but compact 386 computer enters the laptop market.

By Bill Markwick



Intel's 80386 32-bit CPU has caused quite an upheaval in the computer market. Using the new OS2 operating system, and downwardly compatible with MS-DOS, it has everybody who's tried a 386 wishing they could upgrade the old PC, XT or AT (or compatibles). Besides enormous memory capability and flexibility, its speed is enough for all but the most power-hungry.

The Toshiba line of laptop computers now includes an 80386 computer, the T5100, housed in a 12" by 14" (30.5 by 35.5cm) gray case. In the lid is a 640 by 400 pixel plasma display, 7.5" by 6", that lights up in bright orange. The keyboard has a full-size, 82-key unit with the ten function keys across the top; all the functions of the 101-key AT style keyboard are available with a special shift key. To further reduce the width, the separate numeric pad isn't there; the numeric functions take over a section of the regular alphabetic keys when the Num Lock key is pressed.

On the right side is a 3.5" microfloppy drive, on both sides miniscule, quiet fans; on the inside is a 40 megabyte hard drive with a 29ms access time.

The first impression of the T5100 is one of solidity and precise construction. The weight, at 15 pounds, is a tad hefty; not bad for short trips, but quite a pull on the arm if you have to lug it around an airport. The next surprise is that there is no battery, only an AC line cord and power supply that automatically sets itself to the voltage of whatever country you happen to be in. With a power consumption of about 70 watts, I suppose batteries wouldn't go very far, perhaps half an hour, and this may be the reason that Toshiba went with mains-only. Besides, airlines frown on the use of electronic equipment on aircraft in case it interferes with something and you end up in Hamilton instead of Paris.

The T5100 has an elegant fabric carrying case, with a pocket for the manuals and line cord. The computer itself has no carrying handle on the front where you'd expect it, though one does pull out from the rear and tilt down as a stand. This also uncovers the auxiliary connectors.

A Quick Tour

Switching on the power almost instantly brings up crisp orange lettering on a black background to inform you that the computer is under the control of MS-DOS version 3.2, though it's PS-2 ready. This screen is driven by a video card that emulates the IBM Enhanced Graphics Adapter (and also the CGA), and provides four shades of gray; a utility called XCHAD is included to adapt various colors to this gray scale for best contrast, something you'll appreciate if you've ever tried to read white-on-light-blue on a monochrome monitor.

There are controls for brightness and contrast. They seem to work best at maximum when you're in a bright office, though you might want to turn the brightness down in a dimly lit room. Glare is not really a problem because you can tilt the display to suit lighting conditions. On the case beside the lid hinge are the power indicator and disk drive lights, which, oddly, are labelled L and R.

On the rear panel, under the carrying handle/tilt bail lives a 9-pin D-connector serial port, a 25-pin parallel port which can be switched to accept a 5.25" external floppy drive, a 9-pin RGB monitor output connector and an expansion port which is designed for Toshiba products such as a modem, a memory card with another 2MB, or the

5-slot expansion unit which allows you to use IBM- compatible cards externally. A DIP switch allows you to configure a number of parameters such as Extended Memory on/off, 512K/640K and so on.

On the left is the parallel port\disk port switch and a DIN connector in case you want to use an external keyboard.

Tryout

Toshiba didn't send us any software except for DOS and a demo program with remarkably good animation; if you're used to the slow build of PC or even AT animation, the T5100 version will make you think you're watching a movie.

We loaded WordStar version 3, WordStar version 4, and AutoCAD (AutoCAD on a laptop!). Immediately we discovered that WordStar 3 doesn't like the EGA mode; although it runs properly, it won't exit without making a mess of the screen. This is not a fault of the Toshiba, but of WordStar 3 (this has been fixed in version 4). A quick cure for fans of good old Whiz-Com who lust after a laptop is to put WS in a batch file and follow it with MODE CO80. This will restore sanity whenever you exit (MODE.COM is from the DOS utility disk).

WordStar version 4 was much more interesting in terms of the hi-res EGA. It's possible to use WSCHANGE to patch WS for 43 lines (of 80 columns) instead of 25. This lets you see almost all of a full page of text. The T5100 screen was more than up to the task of displaying the much smaller lettering.

AutoCAD loaded much faster than my Best Mark IV, which has an excellent hard drive, an 8MHz 8086 and an 8087 math coprocessor (load time was 5 seconds to the main menu versus 25 for the 8086). After I loaded in the ubiqitous Columbia shuttle, regeneration times were 10 seconds for the T5100 and 11 seconds for the Best. With a much more complex drawing with lots of text, the 8087 edged out the T5100 58 seconds to 62. In other words, the T5100 without a math chip is as fast at AutoCAD as a Turbo 8086 with a math chip. I've used a 386 with a math chip, and AutoCAD regenerates so fast that at first you think something's gone wrong.

The plasma display was really impressive with AutoCAD despite the fact that it's smaller than my hi-res monitor's 8 by 10" screen. In fact, the screen pixels are so precise, I soon came to prefer it. And, of course, who could argue with almost instant operation?

Other Features

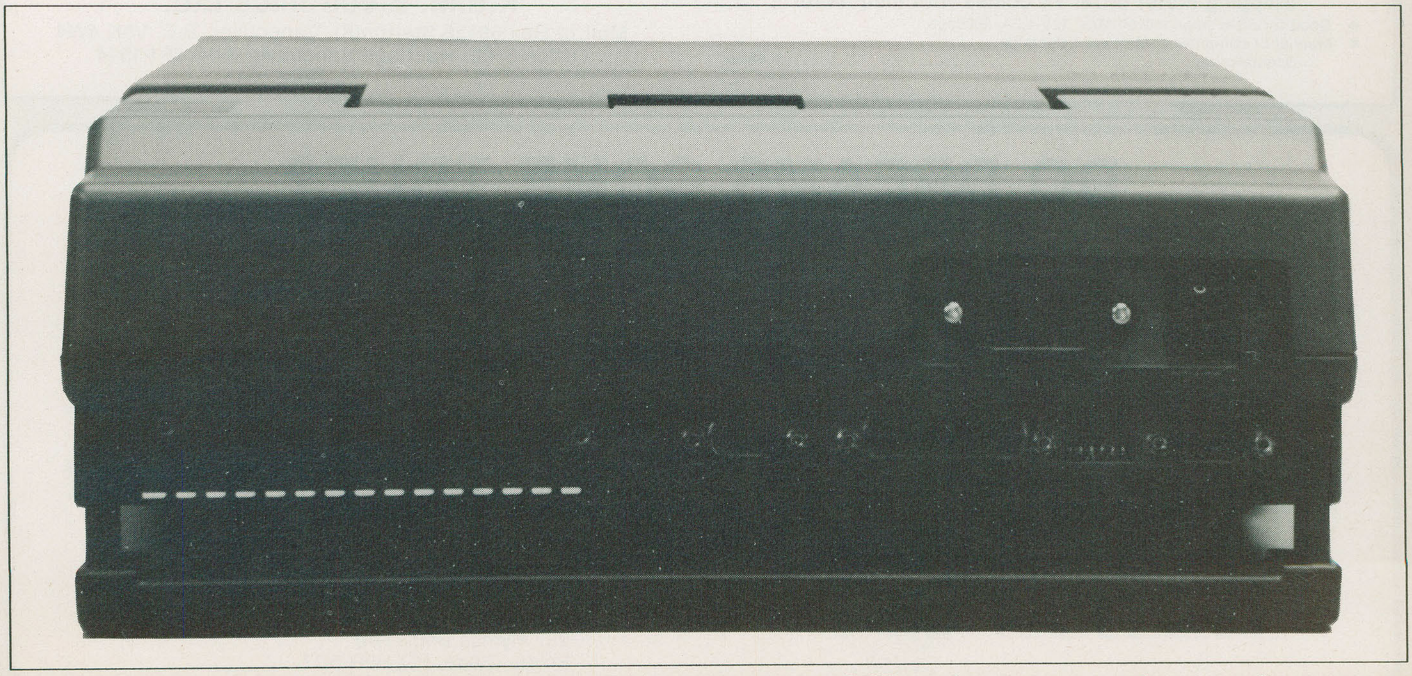
Should you discover some software which doesn't like the 16MHz clock speed, you can use a software switch to set the clock to 8MHz. This is done by pressing the special Fn key and the PgDn key. This FN can also be used to change the character display to a double row of dots, or to change the output to the external RGB socket. It also changes the number of pixels in a row from 350 to 400, and will also simulate keys not present on the keyboard, such as right CRTL and right ALT.

The TEST3 program supplied with the DOS utilities is one of the most comprehensive and easiest to use diagnostic/setup prgrams I've used. You can easily configure the memory for either the Lotus-Intel-Microsoft standard or for expanded memory, set the display gray scale brightness, select the video type, and much more, all done from a full-screen menu. There are all the usual diagnostic routines for the screen, memory, drives, and printer.

For optional equipment, you have a choice of a 5.25" external floppy drive, an expansion interface, a modem, two more megs of RAM, a Floppy Link for connecting to the drive of an existing computer and more.

As to complaints, I can only nitpick. I'd really like a handle on the front, and the lid release is too easy to trip.

You would expect a computer of this comlexity and small size to cost, and it does. The suggested list price at the moment is $11,499. The price of the math chip option depends on the going price for the Intel 80387; at the moment it'll add about $1400 to the total.■



The T5100 handle/stand pulls down to reveal a serial port, a printer/disk port, an RGB monitor connector, and an expansion port.

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Introducing Microprocessors Part 3

The process of fetching, decoding and executing the sequence of instructions which constitutes a program.

By Mike Tooley

Learning Objectives

The general learning objectives for Part 3 are that readers should be able to:

(a) Understand and use a subset of the instruction set of any common 8-bit microprocessor.

(b) Describe, using appropriate diagrams, the microprocessor instruction fetch/execute cycle.

(c) Understand the facilities provided by a monitor program.

The specific objectives for this part are as follows:

2.2 Instruction Sets

2.2.1 Explain what is meant by the terms instruction and instruction set.

2.2.2 Explain the form in which instructions are stored and presented to the microprocessor for execution.

2.2.3 Categorize instructions in the following groups:

data transfer
arithmetic and logical
test, branch and control

2.2.4 Examine the following modes of addressing:

implied
immediate
absolute.

2.2.5 Examine a subset of the instruction set of any common 8-bit microprocessor and identify the types of instruction for data movement (transfer), control, and arithmetic.

2.3 Fetch-Execute Cycle

2.3.1 Explain each stage of the fetch-execute cycle.

2.3.2 Explain the function of the Program Counter, Instruction Register and Instruction Decoder during the fetch-execute cycle.

2.3.3 Draw a timing diagram showing the state of the read, write (or read/write), and bus lines at each stage of the fetch-execute cycle for a representative 8-bit microprocessor.

2.3.4 Draw a timing diagram to show the movement of data during each stage of the fetch-execute cycle.

2.4 Monitor Programs

2.4.1 Use a monitor program.

Instruction and Instruction Sets

The individual commands contained within a microprocessor program are called instructions. Clearly, if a microprocessor is to be capable of performing a variety of operations, a range of different instructions must be available. Some of these will be concerned with moving data from place to place and are aptly known as "data-transfer" instructions. Others are used to perform "arithmetic and logic" functions. A third type of instruction is needed to control the overall flow of the program. Such instructions form part of the "test, branch and control" group.

The microprocessor keeps track of its progress through a series of instructions by regularly updating its Instruction Pointer (or Program Counter). This sixteen bit register effectively points to the address of the next instruction to be fetched in the sequence of execution.

A simple IMP program (expressed in hexadecimal format) might take the form:

3E
01 First instruction (two bytes)
06
02 Second instruction (two bytes)
02
80 Third instruction (one byte)

The five byte program contains three instructions. The first two take up two bytes each whilst the last instruction only requires a single byte. The hexadecimal representation is compact but not very explicit and readers might be forgiven for wondering what the program actually does. Furthermore, writing anything other than the shortest of programs in hexadecimal format is clearly going to be a rather tedious process.

In practice we make use of a mnemonic shorthand for writing our instructions rather than resorting to hexadecimal code. However, even programming in hexadecimal is one step removed from the binary codes that the microprocessor actually requires (readers may be unaware that the first generation of computer programmers actually wrote their code

in binary!).

As far as the microprocessor is concerned, each instruction comprises an individual binary code (the operation code) which may be followed by one of more further bytes (which constitute and operand). The operand qualifies the instruction in some way and typically may be used to form an address at which data is to be stored or from which data is to be fetched. Clearly, if we are dealing with an operand which it used to denote a 16-bit address, it will require two bytes. IMP knows how many bytes to take as an operand since it is implicit in the operation code which it will have previously decoded.

Assembly language

We have already stated that IMP responds to instructions presented in binary form and that a form of shorthand is used to simplify the task of writing a program. This shorthand is known as "assembly language" and it provides us with a means of expressing our programs in terms of a set of mnemonics.

Assembly language is a low-level language which is (relatively) easy for humans to learn and remember and which can quite easily be translated into the binary code required by a microprocessor. The function of translating mnemonic assembly code into binary code is performed by a utility program known as an "assembler". Some assemblers produce intermediate programs in hexadecimal format which are then translated into binary code for final loading into program memory.

Unfortunately, each microprocessor family has its own dialect of assembly language. This makes it difficult (if not impossible) to transfer programs written in assembly language from one microprocessor to another. High level languages, such as BASIC or PASCAL, are much more "portable" since, with a few changes, they can usually be modified to run on a wide variety of machines.

Happily, IMP's assembly language is reasonably conventional. The following instructions (and their hexadecimal equivalents) constitute a small subset of IMP's instruction set. For convenience we have divided these instructions into the three major groups associated with "data transfer", "arithmetic and logic", and "test, branch, and control"

Notes

(a) Mnemonics are used as follows:
LD = LoaD
ADD = ADD
SUB = SUBtract
INC = INCrement
DEC = DECrement
JP = JumP
Z = Zero
NZ = Non-Zero

(b) n and xx represents an immediate data byte (values ranging from 00H to FFH)

(c) nn represents a two byte address (values ranging from 0000H to FFFFH)

(d) ll represents the low byte of an address (values ranging from 00H to FFH)

Readers should note that the general format used for IMP's data transfer instructions involves a destination followed by a source and that these are separated by a comma. As an example, the instruction LD A, B specifies A as the destination and B as the source. It is also important to note that the load instructions do NOT involve the destruction of the source byte; data is effectively copied from source to destination where it replaces whatever was there before the instruc-

Function	Instruction: Mnemonic form	Instruction: Hexadecimal form
Data transfer		
Immediate data to accumulator	LD A,n	3E xx
Immediate data to B register	LD B,n	06 xx
Memory to accumulator	LD A,(nn)	3A ll hh
Accumulator to memory	LD (nn),A	32 ll hh
Accumulator to register B	LD B,A	47
Register B to accumulator	LD A,B	78
Immediate data to HL register pair	LD HL,nn	21
Memory (pointed to by HL register) to accumulator	LD A,(HL)	7E
Accumulator to memory (pointed by HL register)	LD (HL),A	77
Arithmetic and logic		
Add register A to register B	ADD B	80
Subract register B from register A	SUB B	90
Increment register A	INC A	3C
Increment register B	INC B	04
Increment register HL	INC HL	23
Decrement register A	DEC A	3D
Decrement register B	DEC B	05
Decrement register HL	DEC HL	2B
Test, branch and control		
Jump unconditionally to specified IP address	JP nn	C3 ll hh
Jump to specified IP address if zero flag is set	JP Z,nn	CA ll hh
Jump to specified IP address if zero flag is reset	JP NZ,nn	C2 ll hh

tion was executed.

Finally, the meaning of the brackets shown in instructions such as LD A, (HL) are taken to mean "address pointed to by" or " memory location given by". Thus LD, A, (HL) means "load the accumulator with the data found at the address pointed to by the HL register pair". This may sound a little wordy but, in order to avoid confusion, it is important to be quite precise.

Addressing modes

The different ways of locating the data to be used by a microprocessor instruction are referred to as "addressing modes". Three commonly used addressing modes are known as "implied", "immediate", and "absolute".

In the "implied" addressing mode another register pair is used to hold the address of the location being accessed. In IMP's case, the instruction LD A, (HL) is an example of this mode. In the "immediate" mode of addressing the data to be used is contained within the instruction itself (i.e the data in question immediately follows the operation code). The instruction LD A, n is an example drawn from IMP's set. In the "absolute" mode of addressing, the address at which the data is located forms part of the instruction. This mode is exemplified by IMP's LD A , (nn) instruction.

A number of other (more complex) addressing modes exist. These, however, are not really appropriate-to an introductory level module and will be left for readers to explore in the event that they continue with studies at a higher level. For the moment, it is merely necessary for readers to be able to recognize and distinguish between the three modes previously mentioned. The following table summarizes these modes of addressing and includes examples from IMP's instruction set:

Addresing mode	Data located . . .	Example
Implied	. . at an address pointed to by other CPU registers	LD A,(HL)
Absolute	. . at an address specified in the instruction	LD A,(nn)
Immediate	. . in the instruction itself	LD A,n

Problem 3.1

(a) IMP - encounters the hexadecimal values 3E and 00 which appear as successive bytes in a program instruction. What action do they produce?

(b) IMP is performing the assembly language instruction SUB B. If the A register contains the 14H before the instruction was performed and 0AH after the instruction is executed, determine the contents of register B.

(c) A single-byte IMP instruction expressed in binary (MSB first) takes the form 00101011. What action does the instruction perform?

(d) It is necessary to load the HL register pair with 3C02H. What IMP assembly language instruction is required?

(e) What hexadecimal code is used to represent the instruction in (d)?

(f) What addressing mode is used in-the instruction LD A, FFH?

(g) To which group or class of instructions does the instruction LD A, (HL) belong?

The Fetch-Execute Cycle

The operation of a microprocessor is based upon a continuous sequence of events each of which is known as a "fetch-execute" cycle. The fetch-execute cycle involves the following stages:

(a) Fetching the instruction from memory and placing it in the microprocessor's Instruction Register.

(b) Decoding the instruction (using the Instruction Decoder) and determining what subsequent action is required.

(c) If necessary, fetching more data.

(d) Executing the instruction.

This process is illustrated by the flowchart shown in Fig. 3.1.

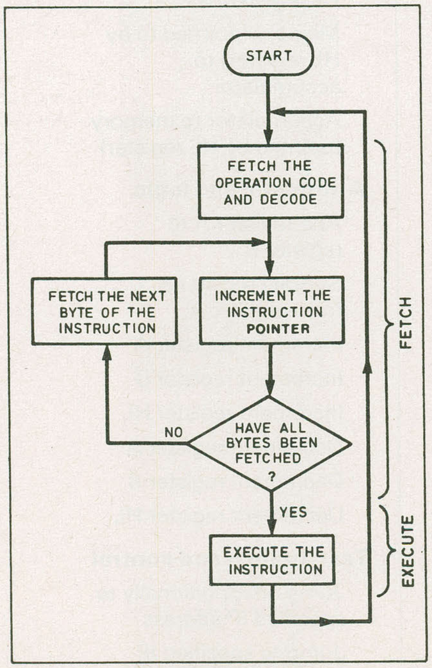


Fig. 3.1. Flowchart for the fetch-execute cycle.

Timing diagrams

Timing diagrams show the relationship between control signals and the data and addresses which appears on the microprocessor buses. Fig 3.2 shows a typical timing diagram which illustrates the sequences of events when IMP performs the instruction LD A, 3F. This fetch-execute sequence occupies just two complete machine cycles. During the first machine cycle, IMP fetches the operation code and decodes it. On the second machine cycle, IMP fetches the data byte (3FH) and copies it into the accumulator.

Read and write operations

When performing memory read or write operations IMP performs different tasks on the first and second half-cycle of the clock. During the first half cycle of the clock signal (i.e. when the clock line is high) IMP Places a valid memory address on the address bus and selects either a read or write operation by taking the R/W line high or low respectively. Data exchanges then take place during the second half of the clock cycle (i.e. when the clock line goes low), the direction of data movement (i.e. to or from IMP) being determined by the previously set condition on the R/W line.

A read cycle (Fig. 3.3) can be used to transfer a byte of data from an address in ROM, RAM, or I/O to one of the IMP's internal registers. A write cycle (Fig. 3.3b), on the other hand, is used to transfer a byte of data from one of the IMP's internal registers to either

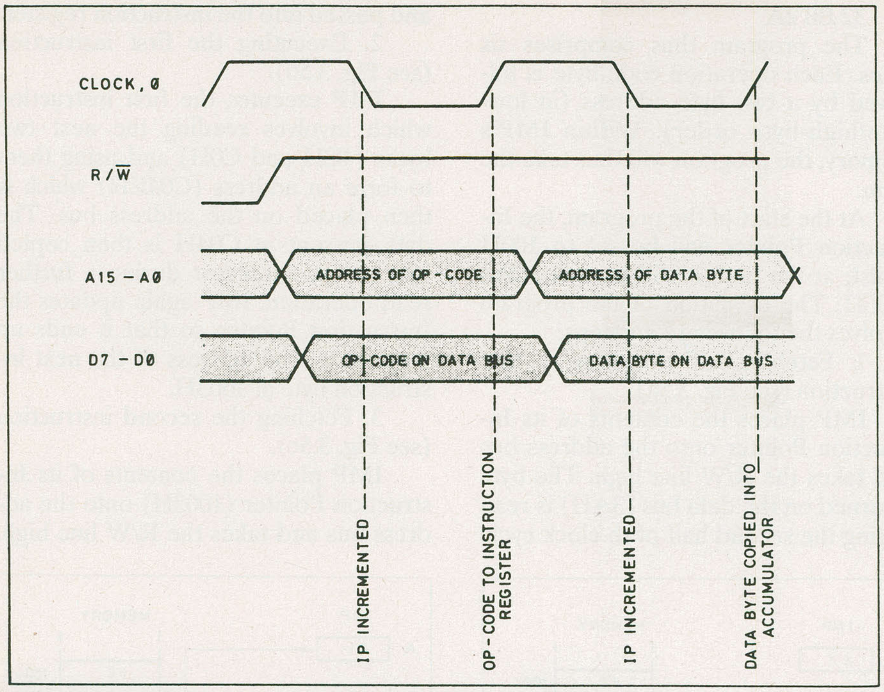


Fig. 3.2. Simplied timing diagram for a fetch-execute cycle.

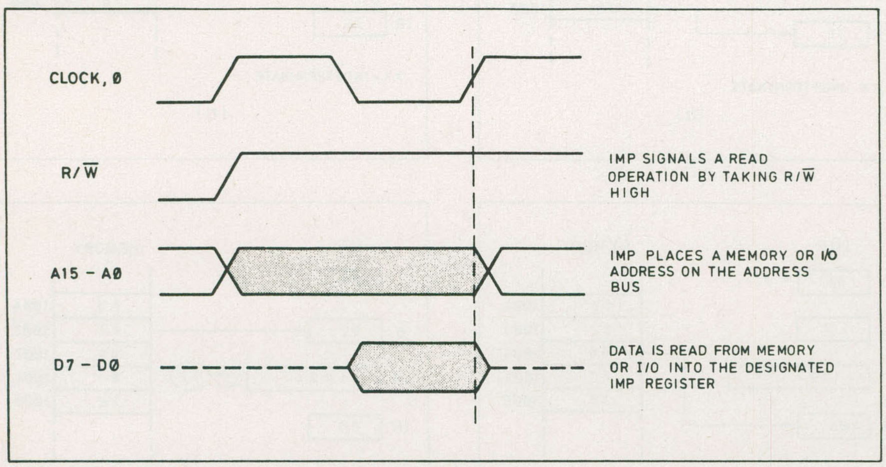


Fig. 3.3a. Simplified timing diagram for a read cycle.

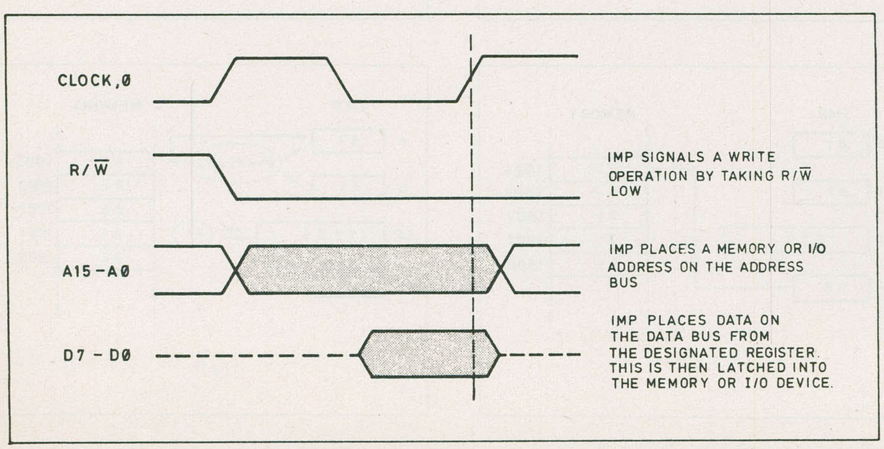


Fig. 3.3b. Simplified timing diagram for a write cycle.

RAM or I/O. Note that, whilst it is possible to undertake a write operation to an address in ROM there is little point in doing so as this would, by definition, have no effect on the contents of the address location in question.

Example 1

Now, let's consider a simple example. Suppose that we wish to add together two bytes of data stored in RAM as part of IMP's program. This task will involve three instructions. The first will load the first operand (in this case a byte of immediate data) into the accumulator (A). The second will load the second byte of data into the B register. Finally, the third instruction will add the contents of the A and B registers and deposit the result back into the accumulator.

We shall assume that the program starts at a hexadecimal address of 1000. Written in assembly language mnemonics, the program looks like this:

```
LD A, 01
LD B, 02
ADD A, B
```

The hexadecimal representation of the program is as follows:

```
3E 01   First instruction
06 02   Second instruction
80      Third instruction
```

Readers will probably have spotted that this program is identical to that which we introduced earlier. Note how each of the two load instructions is followed by the respective data to be loaded. Within IMP's memory, the program will thus take the form:

At the start of the program, the Instruction Pointer will be set to 1000H whilst, at the end, it will have reached 1005H. Execution of the program involves the following steps:

1. Fetching and decoding the first instruction (see Fig. 3.4a).

IMP places the contents of its Instruction Pointer (1000H) onto the address bus and takes the R/W line high. The byte returned on the data bus (3EH) is read during the second half of the clock cycle and passed into the instruction register.

2. Executing the first instruction (see Fig. 3.4b).

IMP executes the first instruction which involves copying the next byte (i.e. that which follows the operation code, 3EH) into the accumulator, IMP also updates the Instruction Pointer so

that it points to the address of the next instruction byte at 1002H.

3. Fetching and decoding the second instruction (see Fig. 3.4c)

IMP places the contents of its Instruction Pointer (1002H) onto the address bus and takes the R/W line high. The byte returned on the data bus (06H) is read during the second half of the clock cycle and passed into the instruction register.

4. Executing the second instruction (see Fig. 3.4d).

IMP executes the second instruction which involves copying the next byte (i.e. that which follows the operation code, 06H) into the B register. IMP also updates the Instruction Pointer so that it points to the address of the next instruction byte at 1004H.

5. Fetching the third instruction (see Fig. 3.4e)

IMP places the contents of its Instruction Pointer (1004H) onto the address bus and takes the R/W line high. The byte returned on the data bus (80H) is read during the second half of the clock cycle and passed into the instruction register.

6. Executing the third instruction (see Fig. 3.4f).

IMP executes the third instruction which involves passing the contents of the A and B registers into the ALU and adding the two bytes together. The result is then passed back into the accumulator (replacing the byte that was originally present). Also note that the byte present in the B register has remained unchanged. IMP also updates the Instruction Pointer so that it points to the address of the next instruction byte at 1005H.

Example 2

Now, as a further example, suppose that we wish to copy a byte of data from an address in ROM (G04EH) to an address in RAM (2AB0H). This task would obviously involve two instructions; a read operation followed by a write operation. We shall again assume that the program again starts at a hexadecimal address of 100H. The program would be written in assembly language as follows:

LD A, (C04EH)
LD (2AB0), A

The hexadecimal machine code corresponding to these two instructions is given below:

3A 4E C0
32 B0 2A

The program thus comprises six bytes. Each operation code byte is followed by a two byte address (in low-byte/high-byte order). Within IMP's memory, the program will thus take the form:

At the start of the program, the Instruction Pointer will be set to 100H whilst, at the end, it will have reached 1006H. The execution of the program involves the following four steps:

1. Fetching and decoding th first instruction (see Fig. 3.5a).

IMP places the contents of its Instruction Pointer onto the address bus and takes the R/W line high. The byte returned on the data bus (3AH) is read during the second half of th clock cycle and passed into the instruction register.

2. Executing the first instruction (see Fig. 3.5b).

IMP executes the first instruction which involves reading the next two bytes (4EH and C0H) and using them to form an address (C04EH) which is then placed on the address bus. The data present at C04H is then copied into the accumulator during a further read operation. IMP again updates the Instruction Pointer so that it ends up pointing to the address of the next instruction byte at 1003H.

3. Fetching the second instruction (see Fig. 3.5c).

IMP places the contents of its Instruction Pointer (1003H) onto the address bus and takes the R/W line high.

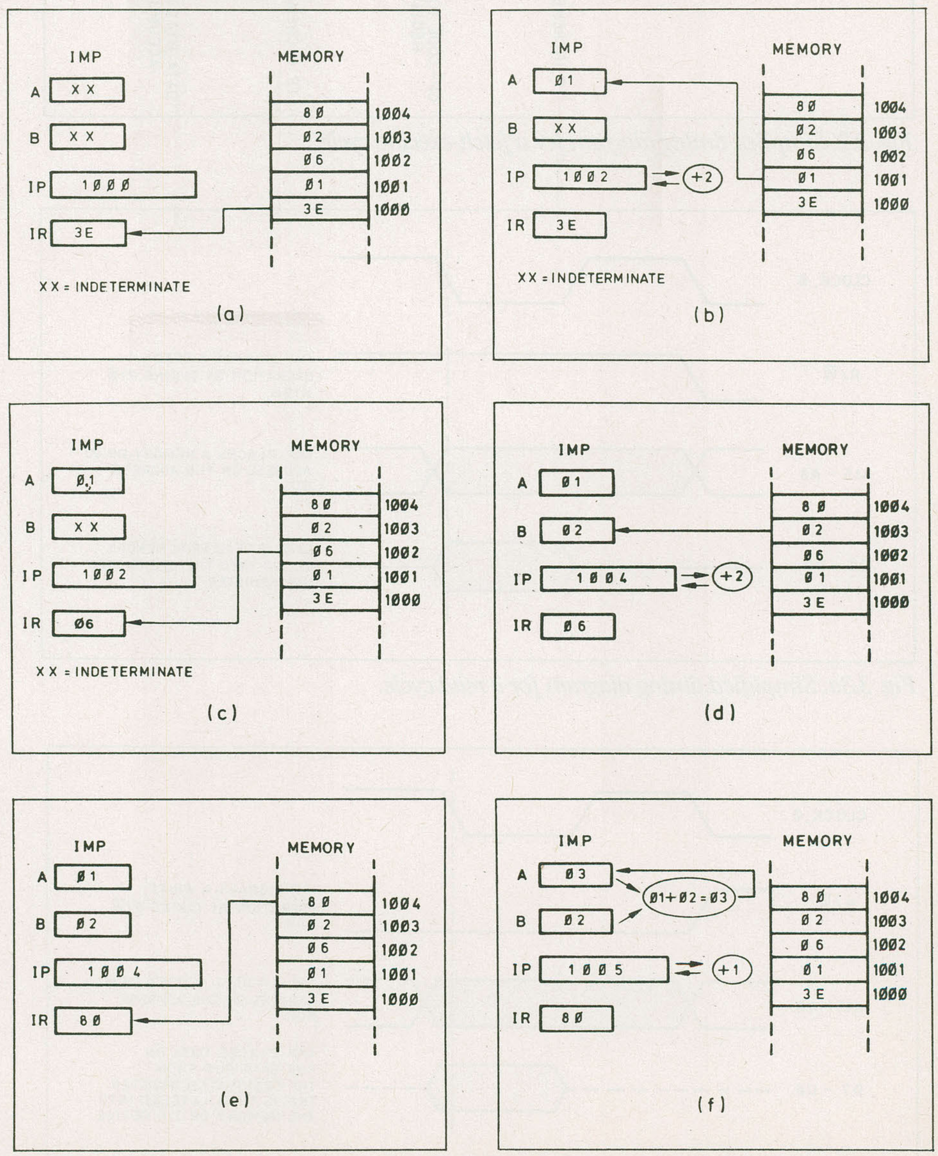


Fig. 3.4. Flow of data between IMP and memory in Example 1.

Address (hex)	Byte (hex)	Function
1000	3A	Operation code for LD A,(nn)
1001	4E	Low byte of address operand
1002	C0	High byte of address operand
1003	32	Operation code for LD (nn),A
1004	B0	Low byte of address operand
1005	2A	High byte of address operand

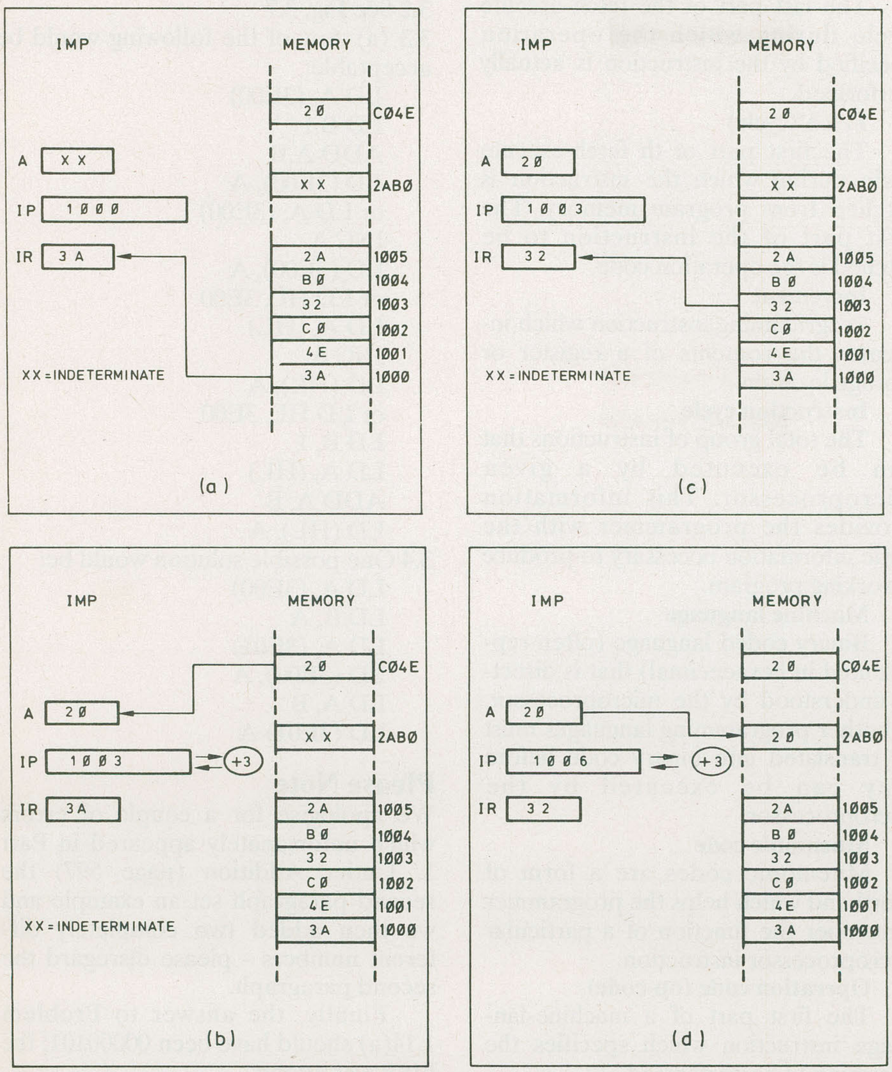


Fig. 3.5. Flow of data between IMP and memory in Example 2.

MACHINE CYCLE	M1	M2	M3	M4
TYPE OF CYCLE	MEMORY READ (OP-CODE FETCH)	MEMORY READ	MEMORY READ	MEMORY WRITE (EXECUTE)
ADDRESS BUS	IP (LOCATION OF OP-CODE BYTE)	IP+1 (LOCATION OF SECOND INSTRUCTION BYTE)	IP+2 (LOCATION OF THIRD INSTRUCTION BYTE)	ADDRESS ASSEMBLED FROM DATA READ DURING M2 & M3
DATA BUS				

Fig. 3.6. Table for Problem 3.2.

The byte returned on the data bus (32H) is read during the second half of the clock cycle and passed into the instruction register.

4. Executing the second instruction (see Fig. 3.5d).

IMP executes the second instruction which involves reading the next two bytes (B0H and 2AH) and using them to form an address (2AB0H) which is then placed on the address bus. The data present in the accumulator is then written to address 2AB0H during a final write operation. IMP also updates its Instruction Pointer so that it ends up pointing to the address of the next instruction byte at 1006H. Readers should now be getting a feel for the way in which IMP operates. In particular, the following should be noted:

(a) instructions may comprise one, two, three (or more) bytes.

(b) instructions comprise an operation code which may be followed by a further byte or bytes which constitutes an operand.

(c) instructions may involve further read and/or write operations, not just fetching (i.e. reading) the instruction itself.

Problem 3.2

Fig. 3.6 shows the sequence of operations which occur during the fetch-execute cycle associated with the instruction LD (2E00), A. Given that the accumulator contains 7FH immediately before the instruction is executed, complete the table showing the byte present on the data bus at each stage of the fetch-execute cycle.

Problem 3.3.

Write simple assembly language programs (using only the given subset of IMP's instruction set) which will:

(a) add 1 to the data stored in memory location 3E00H,

(b) exchange the data bytes present at memory locations 3E00H and 3E01H.

Monitor Programs

Monitor programs provide us with a variety of useful facilities which can not only aid our understanding of the operation of a microprocessor but also allow us to enter, test and debug simple programs. A typical monitor program comprises about 2K of code and provides the user with the means to:

(a) display the contents of a given block of memory in hexadecimal and ASCII (see note 1) format

(b) modify or edit hexadecimal bytes in memory

(c) display the contents of the CPU registers

(d) modify the contents of the CPU registers

(e) disassemble a given block of memory into assembly language mnemonics

(f) insert breakpoints (see note 2) into a program

(g) execute a program from a given start address until a breakpoint is encountered

(h) trace the execution of a program with a continuous display of the CPU registers and memory contents as each instruction is executed.

Notes:

1. ASCII stands for "American Standard Code for Information Interchange". The ASCII code is commonly used for representing alphanumeric characters (i.e. letters, numbers and punctuation) within a microprocessor system. Each character is represented by a single byte (i.e. 8 bits). Since the standard ASCII code uses seven bits, the leading (i.e. most significant) bits, the leading (i.e. most significant) bit is either ignored or used to distinguish special graphic characters or tokenized keywords.

2. A breakpoint is a code (usually a single byte) inserted into a program during testing or debugging which, when encountered during the course of a program, suspends execution and returns control to the monitor program. This facility allows the user to examine the state of the system when a certain point is reached in the program.

Glossary for Part Three

Address modes

The various methods of specifying an address as part of an instruction.

Assembly program

A program which translates assembly language statements into the binary code machine code which is directly executable by the microprocessor.

Assembly language

Assembly language is a machine-oriented low-level programming language as distinct from human-oriented high-level languages. An assembly language program is normally written as a series of statements using mnemonics. It is then translated into machine code by an assembler program.

Decrement

Programming instruction which decreases the contents of a register or storage location.

Execute (cycle)

The last part of the fetch-execute cycle during which the operation specified by the instruction is actually performed.

Fetch (cycle)

The first part of th fetch-execute cycle during which the instruction is fetched from program memory. The first part of the instruction to be fetched is the operation code.

Increment

Programming instruction which increases the contents of a register or storage location.

Instruction cycle

The total group of instructions that can be executed by a given microprocessor. This information provides the programmer with the basic information necessary to produce a working program.

Machine language

Binary coded language (often represented in hexadecimal) that is directly understood by the microprocessor. All other programming languages must be translated into binary code before they can be executed by the microprocessor.

Mnemonic code

Mnemonic codes are a form of shorthand which helps the programmer remember the function of a particular microprocessor instruction.

Operation code (op-code)

The first part of a machine-language instruction which specifies the operation to be performed.

Answers to Problems

3.1 (a) load the accumulator with immediate data of 00H

(b) 0AH

(c) DEC HL

(d) LD HL, 3C02

(e) 21 02 3C

(f) immediate

(g) data transfer

3.2 See Fig. 3.7

3.3 (a) Any of the following would be acceptable:

```
LD A, (3E00)
LD B.1
ADD A,B
LD (3E00), A
or LD A, (3E00)
INC A
LD (3E00), A
or LD HL, 3E00
LD A, (HL)
INC A
LD (HL), A
or LD HL, 3E00
LD B, 1
LD A, (HL)
ADD A, B
LD (HL), A
```

3.4 One possible solution would be:

```
LD A, (3E00)
LD B, A
LD A, (3E01)
LD (3E00), A
LD A, B
LD (3E01) A
```

Please Note

We apologise for a couple of errors which unfortunately appeared in Part 1. Under Addition (page 597) the second paragraph set an example and we then added two completely different numbers - please disregard the second paragraph.

Finally, the answer to Problem 1.14(a) should have been 00000101; the MSB was wrong.

MACHINE CYCLE	M1	M2	M3	M4
TYPE OF CYCLE	MEMORY READ (OP-CODE FETCH)	MEMORY READ	MEMORY READ	MEMORY WRITE (EXECUTE)
ADDRESS BUS	IP (LOCATION OF OP-CODE BYTE)	IP+1 (LOCATION OF SECOND INSTRUCTION BYTE)	IP+2 (LOCATION OF THIRD INSTRUCTION BYTE)	ADDRESS ASSEMBLED FROM DATA READ DURING M2 & M3
DATA BUS	32 (OP-CODE)	ØØ (LOW BYTE OF ADDRESS OPERAND)	2E (HIGH BYTE OF ADDRESS OPERAND)	7F (BYTE FROM ACCUMULATOR)

Fig. 3.7. Answer to Problem 3.2.

Capacitance Meter

An easy-to-use test meter that will check values from 100p to 1000uF. Invaluable for checking unmarked capacitors.

By Andy Flind

A multimeter, which will measure resistance directly on suitable ranges. This is only right, considering that the resistor is the most frequently used component in many circuits. The next most common item is the capacitor however, and by contrast, it is generally quite difficult to check the value of one of these. The generally accepted method is with a capacitance bridge, but few hobbyists seem to possess one. Probably because a good bridge is expensive. Also, a certain amount of experience is often required to operate it. Obviously, a need exists for a simple, inexpensive capacitance measuring instrument.

The Capacitance Meter described here is as simple to use as a voltmeter. The capacitor is placed across the terminals, a suitable range selected, and the value can be read on pressing a button. Should it be out of range the meter will read zero or full scale, indicating the direction of range switching needed.

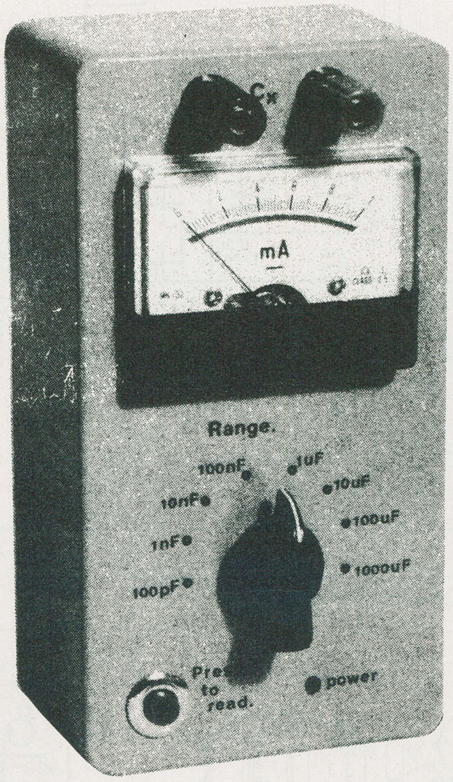
Despite its simplicity it offers ranges from 100pF to 1000uF, greater than most previous designs. At one extreme it can measure the few picofarads between tracks on stripboard, at the other the actual value of a 470uF electrolytic can be indicated. Despite their enormous tolerance factors these still appear as "timing" capacitors in some projects.

How It Works

Although simple to use, the instrument's operation is moderately complex and requires some explanation. The block diagram for the Capacitance Meter is shown in Fig. 1.

The capacitor being checked, *Cx*, is connected as the timing element in a simple oscillator circuit built around 7555 timer.

During positive half-cycles of oscillation, capacitor *C* is charged through resistor *R*. Whilst the output is negative this capacitor is discharged through the timer's own discharge transistor. The maximum voltage reached across *C* therefore depends on the length of the charge periods, which in turn depend upon the value of *Cx*.



The rate of rise of voltage across *C* is in fact exponential, but as full scale corresponds to only about a fifth of the supply voltage the voltage reached is practically linear with time. The maximum value is detected, and with suitable values of *C* and *R* gives a direct indication of the value of *Cx*.

Where *Cx* is above, say, 100uF the frequency of oscillation is low, a few hertz at most. Greater speed would require too much current for the intended battery operation.

A low frequency rules out any form of "averaging" output circuit though, as this would take an unreasonably long time to settle. Instead, a sample-hold technique is used. The peak detector follows the voltage on *C* as it rises, then remains at the maximum value reached.

A second oscillator drives circuitry that periodically reads and stores the detected voltage before resetting it. The meter indicates the currently stored voltage. The frequency at which this happens is about 1Hz; the meter can be seen "stepping" and should reach a stable reading within two or three cycles, regardless of the range in use.

Circuit Description

The full circuit diagram for the Capacitance Meter appears in Fig. 2. the oscillator follows the simplest possible arrangement, *Cx*, the capacitor "under test" being connected between ground and IC1 pins 2 and 6, with a single feedback resistor from the output, the value of which is selected by "Range" switch S1a.

The lowest resistor value required for the 100uF and 1000uF ranges, is 100 ohms. IC1's output cannot provide enough current for this so transistors TR1 to TR4 buffer it. The coupled collectors of TR3, TR4 follow pin 3, but provide greater current.

While positive, they also charge capacitor C1 through the resistor selected by S1b. Whilst they are negative C1 is discharged rapidly through IC1 pin 7, behind which lurks the chip's "discharge" transistor.

If the voltage on C1 exceeds that on capacitor C2, IC2, through TR5, pulls C2 up to match it. Initially there is a discharge path across C2 so it will retain the highest voltage reached.

Sample-holding is implemented through IC3, a CMOS 4016B "quad analogue switch". Switches IC3c and IC3d are connected as an astable oscillator, the frequency being set by capacitor C5 and resistor R21 to about 1Hz.

There are two outputs, appearing across resistors R17 and R22, which go positive alternately. As they do so, they pulse the two remaining switches IC3a and IC3b for brief periods set by R18, C4 and R16, C3. When IC3a is closed, the voltage on capacitor C2 is transferred to capacitor C6; when IC3b closes resistor R15 leaks some charge from C2. Between each "read" and "discharge" pulse there is plenty of time for C2 to

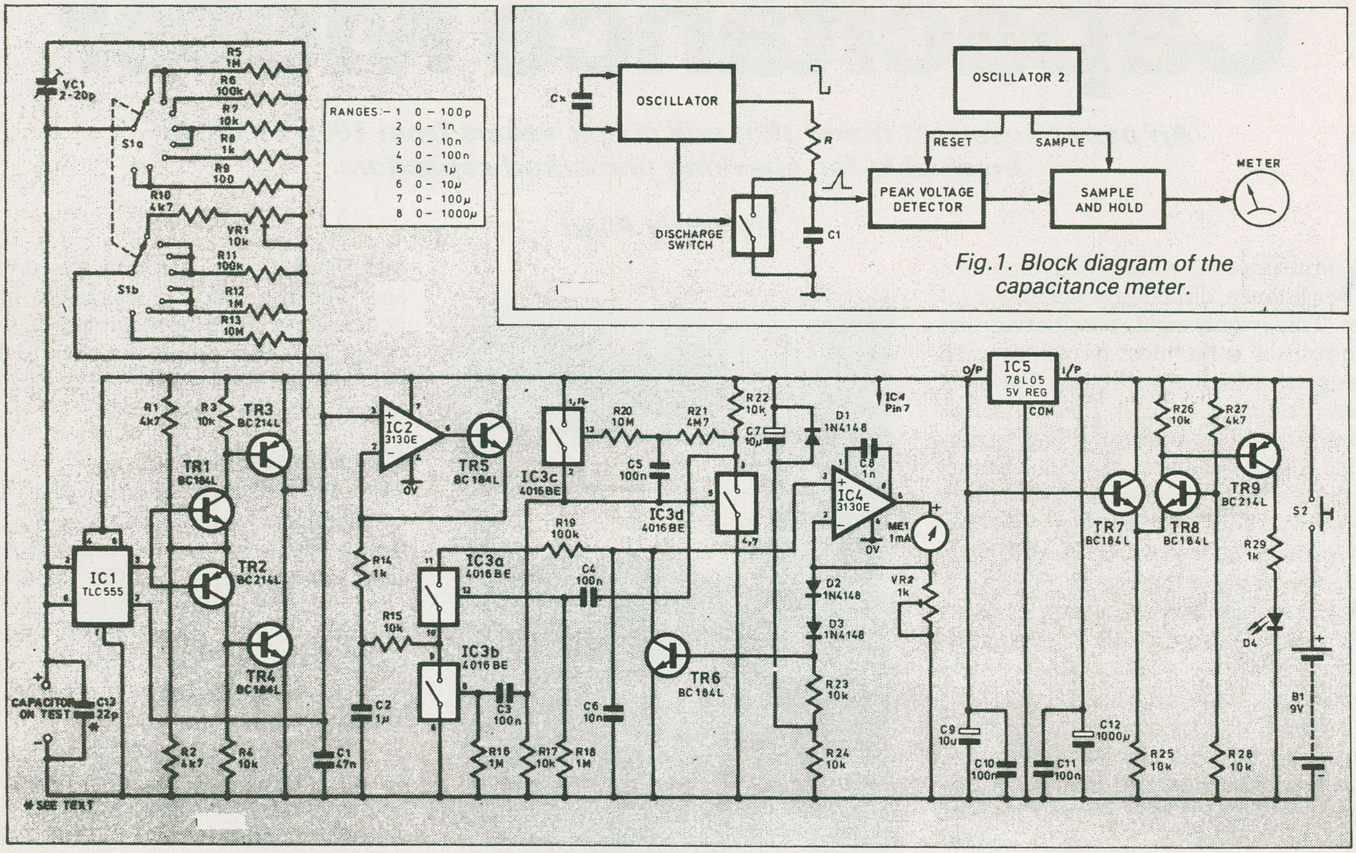


Fig.1. Block diagram of the capacitance meter.

Fig 1. Complete circuit diagram for the Capacitance Meter.

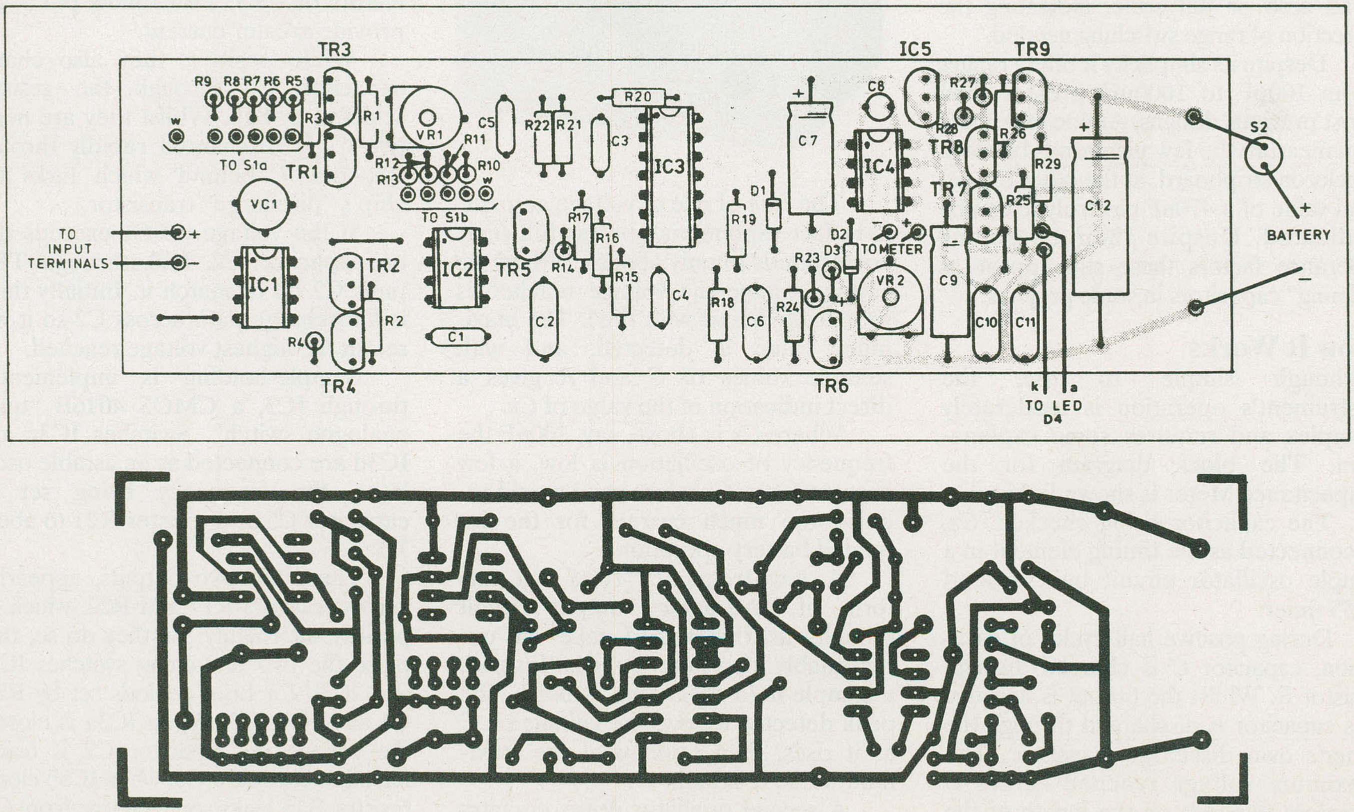


Fig 2. Printed circuit board component layout, interwiring details to case mounted components and full size underside copper foil master pattern.

regain the peak value from C1, at even the slowest operating speed.

A simple voltage-to-current arrangement for displaying the voltage from capacitor C6 on the meter, is made up by the components around IC4. Transistor TR6 is a clamp circuit for limiting the maximum input.

In the course of design it was found that on powering up, the meter drove hard to full scale. The cause seemed to be some form of breakthrough occurring in IC3 as the supply voltage first appeared across this chip. As push-button operation was intended, and the sight of the meter being overdriven each time was disconcerting, a cure was provided by capacitor C7, which operates the clamp briefly as power is applied.

A stable supply voltage is necessary, this being provided by the 5V regulator IC5. Transistors TR7 to TR9 compare the battery voltage against the regulated supply and drive LED D4. So long as the battery is healthy the LED is lit, but it extinguishes sharply at around 7.5V.

Low Values

The difficulty of measuring large capacitors has been mentioned but at the other end, the 0 to 100pF scale presents its own problems. This is likely to be very useful to radio enthusiasts, so it should be as accurate as possible.

During breadboarding, it was found that the meter would not zero on this range due to stray input capacitance, probably including that of IC1. The solution was the use of the variable capacitor VC1, which can be adjusted to neutralize the strays. When the complete instrument was assembled however, the imbalance had swung the other way.

The range-switch wiring was contributing too much neutralizing capacitance on its own. A 22pF polystyrene capacitor was placed directly across the input, which allowed zero adjustment with VC1 as before.

There remains some nonlinearity across this range, about five per cent of scale, which is probably unavoidable in a simple meter of this type. Options for dealing with this will be described in the setting-up procedure.

Construction

Before commencing construction, care should be taken to set that the board is clean. Parts of this circuit operate at very high impedance where leakage can cause substantial errors, so it's worth giving it a wipe with a solvent cleaner and washing one's hands before assembly to prevent any risk of contamination by skin oils, etc.

All the components including the range selection resistors are assembled on a single printed circuit board. The component layout and full size copper foil master pattern being shown in Fig. 3.

In some places components are quite closely packed, so care and a fine-tipped iron are called for. In general it's best to fit components in order of physical height, as this makes for easier handling and less problems keeping them in place while soldering. "Height order" for this project begins with three links, followed by fifteen horizontally mounted resistors.

Sockets are recommended for IC1 to IC4 as this both protects them and aids testing. These ICs should not be plugged in yet. The two variable resistors VR1 and VR3 were "cermets" on the prototype; these are recommended, but standard subminiature types can be used, the board is designed to accommodate either.

When the board is assembled, some testing can be carried out before fitting in the case and wiring to the range switch. A long lead should be connected to the "meter" points (it can be shortened later) and the light emitting diode D4 fitted on about 8cm of lead.

Ribbon cable is suggested for all connections, for neatness and reliability. Temporary leads can be soldered to the battery points for testing.

If the board is now powered with just the LED connected, this should light. Following an initial surge as the electrolytics charge, the consumption should be around 11mA, most of which will be drawn by the LED.

A potential of 5V should appear across capacitor C9, indicating correct operation of IC5. If the facility is available (bench power supply, etc), the supply voltage can be reduced until the LED extinguishes, this should happen about 7 to 7.5V.

If all appears well, the meter can be connected and IC4 plugged in. With potentiometer VR2 set midway, as the board is powered the meter will probably "twitch".

The meter circuit's input can be accessed through pin 11 on IC3's socket (fourth one up, right-hand side). If this is touched with one hand, touching positive supply with the other should cause

PARTS LIST

Resistors
R1,2,10,27 .... 4k7
R3,4,7,15,17,22
R23,24,25,26,28 ....10k
R5,12,16,18 .... 1M
R6,11,19 ....100k
R8,14,29 .... 1k
R9 100
R13, 20 ....10M
R21 .... 4M7
All 0.6 W 1% metal film

Potentiometers
VR1 10k cermet trim, horizontal
VR2 ....1k Cermet trim

Capacitors
C1 ....47n polyester
C2 .... 1u polyester
C3,4,5,10,11 100n polyester
C6 .... 10n polyester
C7,9 ... 10u axial elect, 25V
C8 .... 1n ceramic
C12 ..... 100u axial elec. 10V
C13 22p polystyrene, to fit across input (see text)
VC1 .... 2-20p trimmer
Assorted 1% values for calibration; 10n, 100p-, values below 100p, see text.

Semiconductors
D1,2,3 .... 1N4148
D4 ....red LED.
TR1,4,5 ..2N3904 *npn* silicon
TR2,3,6,7,8,9 2N3905 *pnp* silicon
IC1......... 7555 CMOS timer
IC2, IC4 3130 CMOS op-amp
IC3 4016B CMOS quad analog switch
IC5 78L05 5V 100mA voltage regulator

Miscellaneous
Case, plastic box 150mm x 80 mm x 50mm; PCB, IC sockets 8-pin, 14-pin; S1, miniature shaft assembly, 2-pole 9-way; S2, push-button switch — "press to make"; ME1, 1mA FSD meter; red and black terminal posts; multi-coloured ribbon cable; 9V battery and connector.

the meter to rise, possibly to the stop, while touching negative should cause it to fall. It should hold at random points when the input is open circuit, reading whatever voltage is retained by C6.

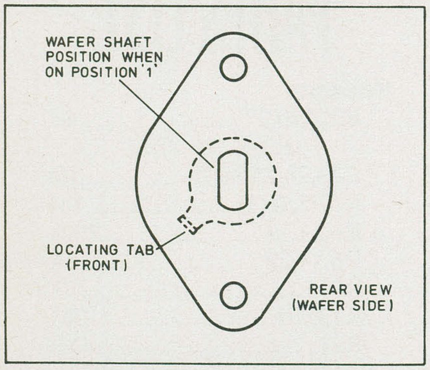


Fig. 3. Position of the range switch shaft assembly prior to fitting the contact wafer.

If this test is successful, IC3 can be plugged in and the board powered again. This time the meter should read zero but a very slight pulsing may be visible at about 1Hz, which may increase when the top of capacitor C2 is touched.

Touching the positive supply with the other hand at the same time should cause the meter to rise but it should return to zero when released, in steps at about 1Hz. Next, IC2 can be inserted after which touching the right-hand side of capacitor C1 with one hand and *positive* supply with the other should cause the meter reading to rise, and C1 with *negative* a fall to zero.

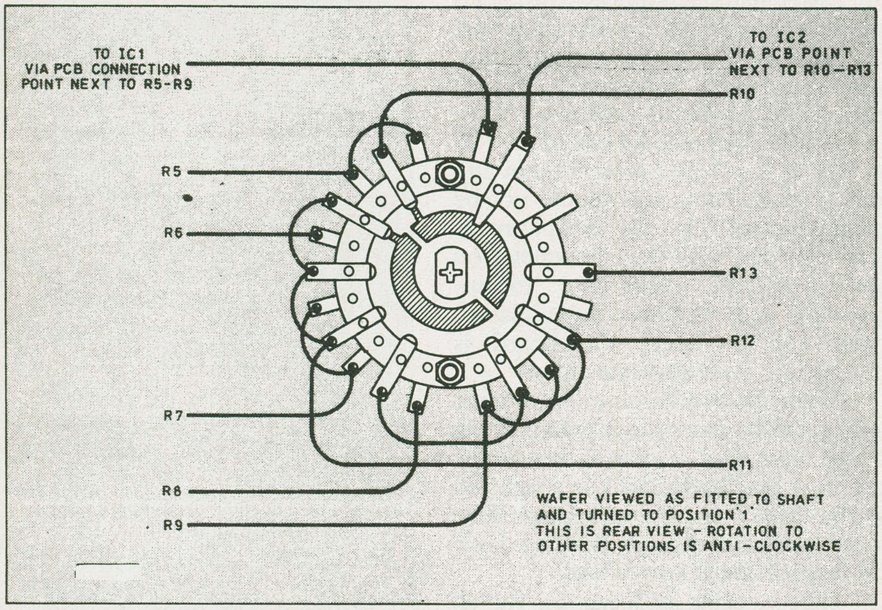


Fig. 4. Interwiring details for the range switch S1. The switch should be wired to the circuit board using 6-way and 5-way multicoloured ribbon cable.

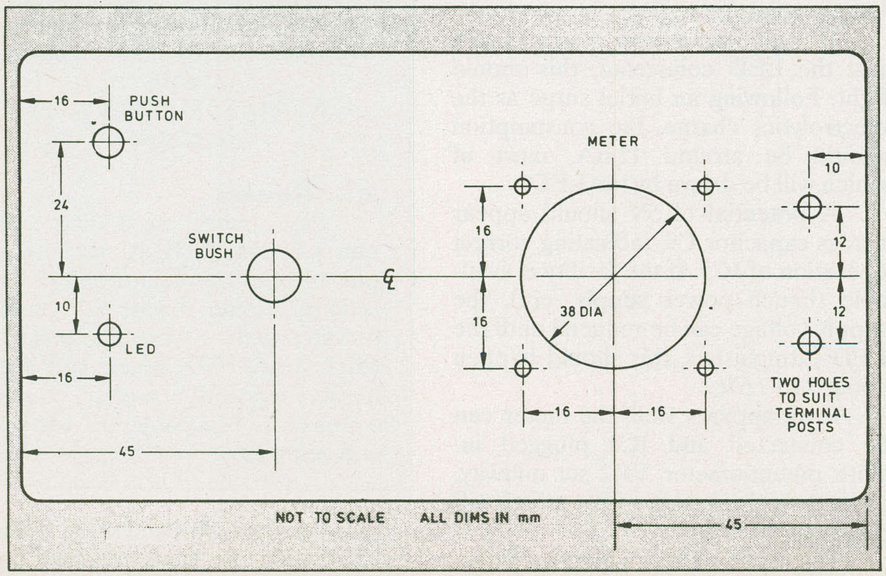


Fig. 5. Case drilling details.

Range Switch

Further testing requires the use of the range switch, so assembly and wiring of S1 should be completed. The ranges provided on the meter require more than one component value to be switchable, so a 2-pole 8-way switch is needed. A "miniature Make-switch" assembly is used as a suitable wafer is available.

The correct assembly and wiring of this is not obvious, so it will be described in detail. The parts required are a "Shaft Assembly" and a "2-pole 9-way" wafer, preferably "break-before-make". A point to note is that the wafer contacts are delicate and may catch and bend if the rotor is carelessly turned before assembly. While they can be straightened again, a watch- maker's skill is called for..

The first step is to remove the nut, lock washer and locating tab from the shaft assembly bush. Adjust the stop to No. 8 and replace the other components with the locating tab facing forwards. Cut the shaft to suit the knob and check that there are indeed eight positions.

Rotate the switch spindle counterclockwise (to position 1), then turn over so that the wafer side is uppermost and the locating tab is lower left, as shown in Fig. 4. Next take the wafer, which has contacts and a rotating centre on each side. It will be seen that one of the removing poles is in one piece, with a single wiping contact, while the other is in two parts with two wipers.

With this latter side facing away from the switch, turn carefully to the position shown in Fig. 5 and fit to the shaft. When wired as shown, the assembly will now provide the two 8-way switches required.

Two separate lengths of multicolored ribbon cable with five and six-ways are used to connect the board to the switch, one for each section. These should be 18cm long, and are soldered first to the board, then to the switch.

On the prototype this was done before assembly into the case, the switch being held in a small vice. The links between contacts are made from insulated wire to avoid risk of shorts.

Case

Detailed case drilling dimensions are given in Fig. 6 as some of the internal clearances are small. The board and

other components are mounted in the case as shown in the photographs, all connections save those to the power supply being made with ribbon cable. The wiring to the circuit board is shown in Fig. 3.

All the wiring passes under the board and the use of ribbon cable makes it easier to lie flat. It should all be long enough to allow the board to be pulled out for access beside the case during calibration.

Red and black input terminals are provided for *Cx* ("capacitor under test"), with the black being connected to the negative supply side of the input, indicating polarity of electrolytic testing. A 22pF polystyrene capacitor (C13) should be connected directly across them.

Calibration

For calibration only, bypass the push-button so that the supply is on continuously while the battery is fitted. A simple short across the button terminals will accomplish this.

Calibration is carried out with suitable test capacitors, 1 per cent silvered mica or polystyrene types being ideal. Begin by connecting a 10nF capacitor across the terminals and switching to the 10nF range. Adjust VR2 for a full scale reading.

This is the only calibration needed for all ranges save 100pF. For this, first connect a 100pF capacitor and adjust VR1 for full scale. Then connect a 10pF and adjust VC1 for 10 per cent scale. Repeat this procedure until the reading is correct at both points.

When calibrated in this way the prototype exhibited some non-linearity on this range, from 20 per cent to 90 percent the readings were a little high. If the lower adjustment was carried out at 22pF instead of 10pF the accuracy improved, but below 22pF the readings became so inaccurate that the ability to indicate values below 10pF was virtually lost.

A slightly better solution was to adjust for "best compromise", but best of all is to calibrate as before, then, with the help of suitable values of silvered mica, mark the cardinal points for this range separately on the meter scale. Quite outstanding accuracy for such a simple meter can be obtained in this way.

Conclusion

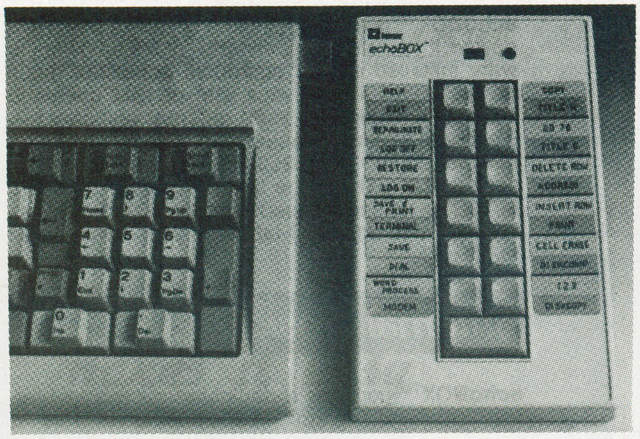
This instrument should prove invaluable in any workshop. It's far quicker and simpler to use than a bridge, and quite accurate enough for most purposes.

The true value of large electrolytic can be easily checked, useful where tolerances can be as much as -20 per cent to +50 per cent. At the other end of the scale, the capacitance between adjacent stripboard copper tacks, ribbon wires and the cores and screens of shielded cables can be measured.

In between it will cope with all those capacitors whose markings are ambiguous or have rubbed off, and with trimmers of uncertain origin and span. Even the effects of temperature on ceramics can be observed. In short, most constructors will soon wonder how they ever managed without it. ■

Circle No. 44 on Reader Service Card

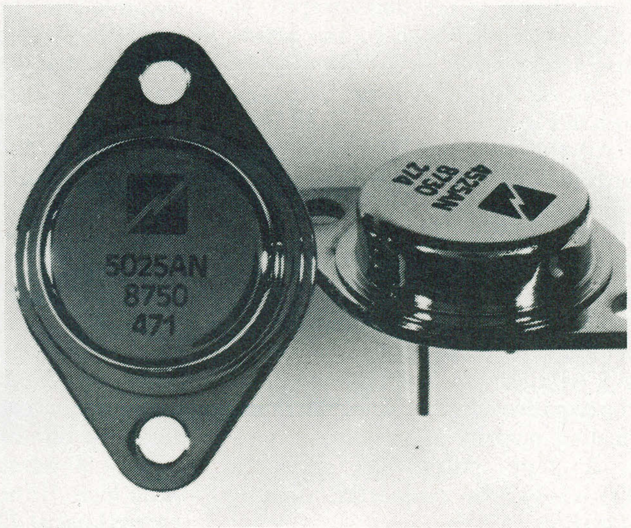
 Continued from page 25



Auxiliary Keyboard

The Smart keypad is a small box which connects between the keyboard and the PC or compatible. It has 12 keys plus a shift key, and can store 24 commands in nonvolatile memory, sending them to the screen when required just as if they had been typed. The keypad eliminates the need for software macros that take up valuable RAM and may cause memory management conflicts. Available as the Model 10X for the PC (up to 950 keystrokes) and the 10A for the AT (up to 650 keystrokes). The entered commands can be changed any number of times. Inmar Inc., 1223 Peoples Avenue, Troy, NY 12180, (518) 271-6692.

Circle No. 37 on Reader Service Card



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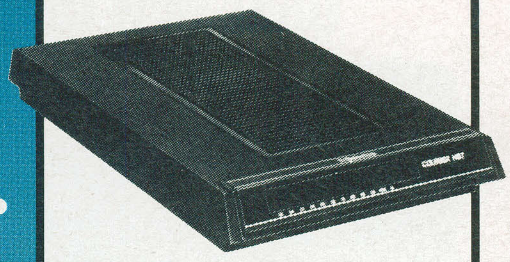

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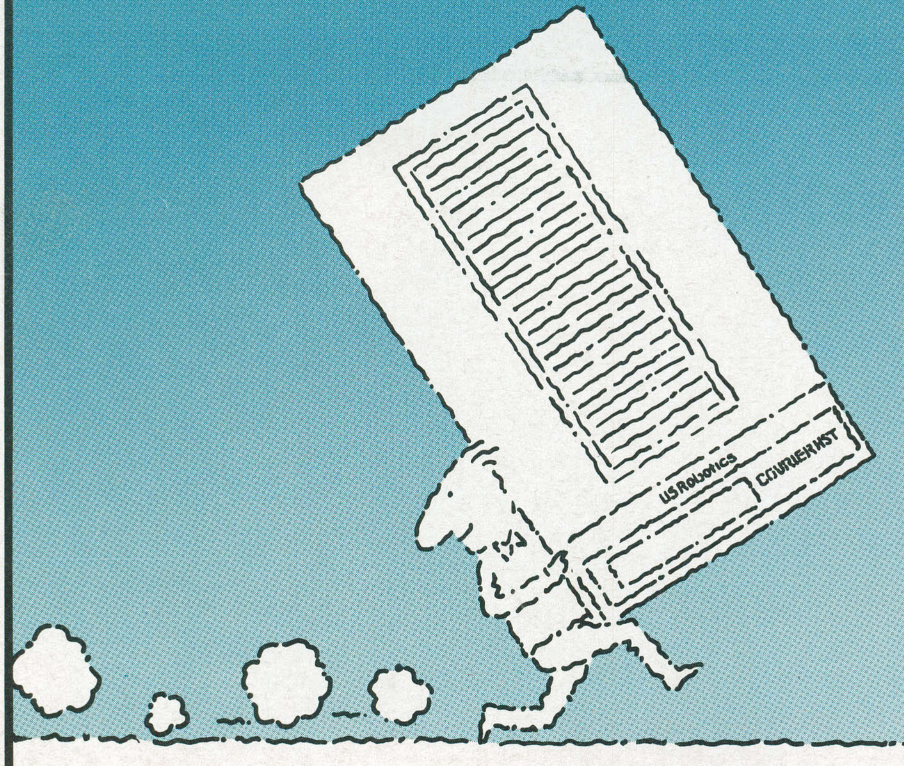

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